3-1-2020

Egyptian textiles and their production: ‘word’ and ‘object’

Maria Mossakowska-Gaubert
Saxo Institute – Centre for Textile Research (CTR), University of Copenhagen, mossakowska@hum.ku.dk

Maria Mossakowska-Gaubert (ed.)

Egyptian textiles and their production: ‘word’ and ‘object’

(Hellenistic, Roman and Byzantine periods)

This volume presents the results of a workshop that took place on 24 November 2017 at the Centre for Textile Research (CTR), University of Copenhagen. The event was organised within the framework of the MONTEX project—a Marie Skłodowska-Curie individual fellowship conducted by Maria Mossakowska-Gaubert in collaboration with the Contextes et Mobiliers programme of the French Institute for Oriental Archaeology in Cairo (IFAO), and with support from the Institut français du Danemark and the Alexander von Humboldt Foundation.

Twelve essays are arranged in 4 sections: I. Weaving looms: texts, images, remains; II. Technology of weaving: study cases; III. Dyeing: terminology and technology; IV. Textile production in written sources: organisation and economy.

Contributors include: Maria Mossakowska-Gaubert, Johanna Sigl, Fleur Letellier-Willemin, Lise Bender Jørgensen, Anne Kwaspen, Barbara Köstner, Peder Flemestad, Ines Bogensperger & Helga Rösel-Mautendorfer, Isabelle Marthot-Santaniello, Aikaterini Koroli, Kerstin Dross-Krüpe, Jennifer Cromwell, and Dominique Cardon. With 66 full-colour illustrations.

Cover photo: Large fabric and yarns dyed in the same dye bath © Helga Rösel-Mautendorfer.

Zea Books
Lincoln, Nebraska

University of Nebraska Lincoln

ISBN: 978-1-60962-153-7
doi 10.32873/unl.dc.zea.1077

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Composed in Sitka, IFAO Greek, and Rockwell types.

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Print edition available from
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In memory of my mother
Lucyna Mossakowska
(1937-2017)
— M. M.-G.

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Part IV. Textile production in written sources: organisation and economy

Introduction

Maria Mossakowska-Gaubert

This volume presents the results of a workshop, which took place on 24 November 2017 at the Centre for Textile Research (CTR), University of Copenhagen. The event was organised within the framework of the MONTEX project[1]—a Marie Skłodowska-Curie individual fellowship conducted by Maria Mossakowska-Gaubert in collaboration with the *Contextes et Mobiliers* programme of the French Institute for Oriental Archaeology in Cairo (IFAO), and with support from the Institut français du Danemark and the Alexander von Humboldt Foundation.

Bringing together archaeologists, historians, philologists and papyrologists, this work compares different points of view on raw materials, looms, the technology of weaving and dyeing, as well as the organisation of textile production in Egypt in the Hellenistic, Roman and Byzantine periods. It also involves an attempt to identify a "word" with an "object". Indeed, when an "archaeological object" is mentioned, what first comes to mind are its form, the way it is produced and decorated, and lastly the way in which it is used. It is quite unusual for archaeological publications to ask what the object was called. Meanwhile, both literary and documentary texts offer an exceptional abundance of words defining such items. However, the lexicographical interpretation of the terms proposed in dictionaries does not always correspond with the chronological, geographical, or technological realities that determined the production and usage of the investigated artefacts.

In order to provide answers to some of these issues, the present volume includes new material from excavations with innovative interpretations, recent studies on material from collections, experimental dyeing and weaving investigations, presentations of iconographical material, as well as historical and sociological studies based on papyrological documentation and literary texts. It also contains lexicographical research into Greek and Coptic vocabulary.

The subject of the provision of raw materials leads to questions regarding flax growing (Isabelle Marthot-Santaniello). The cultivation of flax was without any doubt widespread in Egypt throughout antiquity, but compared to wheat or barley, there are very few records in documentary texts of flax being grown.

An identification of weaving looms needing a special pit in which to set them (Johanna Sigl), a discussion of an overlooked image of a specific kind of loom on a painted tunic from Saqqara, as well as an enquiry into the varied Greek vocabulary concerning looms and specialised weavers (Maria Mossakowska-Gaubert) all reflect technological developments and innovations in the domain of weaving. In addition, the issue of the technique and the looms for silk samite from Late Roman and Early Medieval Egypt is connected to questions about the origin of these textiles (Barbara Köstner).

Testimony from papyrological texts combined with experimental archaeology could provide new data about

Published in Maria Mossakowska-Gaubert, ed., *Egyptian textiles and their production: 'word' and 'object' (Hellenistic, Roman and Byzantine periods)* (Lincoln, NE: Zea Books, 2020). doi 10.32873/unl.dc.zea.1078

1 MONTEX: MONKS, NUNS AND TEXTILES: Production, Circulation, and Distribution of Textiles in the Monastic Environment in Egypt (4th-8th Centuries AD): Marie Skłodowska-Curie Actions (MSCA 701479). Project is hosted by the University of Copenhagen (Saxo-Institute: CTR), and its secondment institution is the Université Paris Ouest – Nanterre La Défense (France).

another branch of textile technology and industry: dyeing (Ines Bogensperger and Helga Rösel-Mautendorfer). What's more, dyeing or dyed fabrics are very often mentioned in Greek literature, and the related vocabulary is very rich (Peder Flemestad).

Textiles found on the "margins" of Egypt—Abu Sha'ar on the Red Sea (Lise Bender Jørgensen) and El-Deir in Kharga Oasis (Fleur Letellier-Willemin)—shed new light on fibres (linen, wool, cotton), various decorative techniques as tapestry or taqueté, as well as on the sociological context of textile use.

We have some information about the organisation of textile production and trade in an oasis environment from papyrological documentation. This documentation also provides a reach vocabulary of textile industry (Jennifer Cromwell). Request papyrus letters, being a separate epistolary category, give testimony about various aspects of textile production and use in late antique Egypt (Aikaterini Koroli). In addition, the question of the function of an ἱστωνάρχη—a title attested in documentary texts—seems to be crucial to understanding the organising system of professional textile production in Roman Egypt (Kerstin Droß-Krüpe).

Lastly, when talking about the production of a garment, one should mention the practice of reusing finished garments to create other garments. Completely new data about this phenomenon are provided by the analysis of a tunic preserved in the Louvre (Anne Kwaspen).

Alongside economic and sociological elements, all of these studies, dealing with the history of techniques, technology and work organisation, the provision of raw materials, and the appearance of looms, combine all the categories of written, archaeological and occasionally iconographic sources, in order to bring new elements to the "puzzle" of the economic and social history of Egypt, as well as opening new research perspectives.

Acknowledgments

I would like to thank all the partner institutions whose support enabled me to organise the workshop in November 2017. My special thanks go to colleagues and friends from the University of Copenhagen: Eva Andersson-Strand, Marie-Louise Nosch, Magdalena Öhrman, Sandy Rizvic as well as Carsten Holt, whose dedication allowed the workshop to take place on the scheduled date.

I would like to thank all the participants of the event and invited authors for their important contributions. My particular thanks go to Dominique Cardon, one of the participants of the workshop, for agreeing to write a Conclusion to the present book. I am grateful to both of our referees, who must remain anonymous, for devoting their time and their knowledge in commenting on the articles submitted for publication.

I would also like to thank Colin Clement for verifying the English throughout the book. This publication was made possible thanks to the wonderful cooperation with Zea Books and their editor Paul Royster.

This book is published with the financial support of the MONTEX programme and the IFAO.

Contributors

Lise Bender Jørgensen is Emerita Professor of Archaeology at the Norwegian University of Science and Technology in Trondheim. A Danish national, she studied archaeology at the University of Copenhagen. Before moving to Norway, she had a spell of teaching archaeology at Göteborg University in Sweden, and later held an adjunct professorship in textile science at the University of Borås in Sweden. She has excavated in Scandinavia, Egypt and Turkey, and has travelled widely in Europe recording archaeological textiles. She is the author of two monographs on Scandinavian and North European textiles from their beginnings up to 1000 AD, co-author of a volume on creativity in the Bronze Age and of three volumes publishing excavations of Viking age and renaissance sites in Denmark. She is one of the founders of the North European Symposium of Archaeological Textiles and has directed and participated in research projects on Roman textiles from Egypt, on wool sails for Viking ships, and on how to deal with non-discursive knowledge in textile craftsmanship. She is currently working on Neolithic textiles from Çatalhöyük in Turkey.

Ines Bogensperger studied classical archaeology at the University of Vienna, Austria. She is currently a PhD candidate in ancient history. During her work at the Papyrussammlung of the Austrian National Library, Vienna, she gained experience in the field of late antique textiles from Egypt as part of the research project *forMuse*. Her exploration of the evidence regarding textiles in documentary papyri, combining textile research with papyrology, was supported by a research grant–*Texts and Textiles in Late Antique Egypt*–from the Austrian Research Fund. In addition, she launched the initiative *Ancient Textiles–Modern Hands* to engage a broader public audience in textile research. She has organised several exhibitions and lectures to build relationships between academia and textile artists.

Dominique Cadron is a senior scientific researcher with the French National Centre of Scientific Research (CNRS), research unit CIHAM/UMR 5648, Lyon, France. She received the CNRS silver medal in 2011. Her long-pursued research themes are the history and archaeology of textile production and dyeing. She has studied and published series of archaeological textiles, including textiles from six Roman *praesidia* and a Hellenistic gold mine site in the Eastern Desert of Egypt, and textiles from Bronze Age and Iron Age sites in the Taklamakan desert, excavated by the Franco-Chinese archaeological mission of Xinjiang. D. Cardon is the author of several books on natural dyes, one of which received the L'Oréal Foundation's Art and Science of Colour Prize in 2003. As scientific director of the International Symposium/Workshop on Natural Dyes in India, Korea, Taiwan, France, Madagascar and recently China, she was awarded the UNESCO medal "Thinking and Building Peace" in 2006. She was made Chevalier de la Légion d'Honneur in France in 2015 and Chevalier de l'Ordre des Arts, des Lettres et de la Culture of Madagascar in 2017.

Jennifer Cromwell is a lecturer in ancient history and member of the Manchester Centre for Youth Studies at Manchester Metropolitan University. Previously, she has held research positions in the University of Oxford, Macquarie University (Sydney), and the University of Copenhagen, where she was a Marie Skłodowska-Curie Research Fellow. Her research interests broadly lie in the social and economic history of Egypt from the 4th to 8th centuries AD, with particular focus on the evidence provided by Coptic

non-literary texts. She is the author of *Recording Village Life: A Coptic Scribe in Early Islamic Egypt* (Ann Arbor, 2017) and co-editor of *Scribal Repertoires in Egypt from the New Kingdom to the Early Islamic Period* (with Eitan Grossman; Oxford, 2017) and *Ptolemy I and the Transformation of Egypt, 404–282 BCE* (with Paul McKechnie; Leiden, 2018).

Kerstin Droß-Krüpe is currently a post-doctoral assistant at Kassel University. She studied classical archaeology, ancient history and business administration at Philipps-Universität Marburg and obtained her PhD in 2010 with a thesis concerning textile production during the Roman Empire in the province of Egypt, published as *Wolle – Weber – Wirtschaft. Die Textilproduktion der römischen Kaiserzeit im Spiegel der papyrologischen Überlieferung* (Wiesbaden 2011). In 2014 and 2016 she edited several volumes on ancient economic history: *Textile Trade and Distribution in Antiquity* (Wiesbaden 2014), *Textiles, Trade, and Theories* (Münster 2016, with Marie-Louise Nosch), *The Cultural Shaping of the Ancient Economy* (Wiesbaden 2016, with Sabine Föllinger and Kai Ruffing). Her current research project deals with the reception of the "Babylonian" queen Semiramis in Baroque opera.

Peder Flemestad is a classical philologist. He is currently a PhD candidate at Lund University, Sweden, and an affiliated researcher at the Centre for Textile Research at the University of Copenhagen, Denmark; his project investigates issues of dress and identity in Imperial Greece. He has previously held various teaching and research positions at the University of Copenhagen (2005-2016), and has worked for the *Tracking Colour* project at the Ny Carlsberg Glyptotek. His research interests include ancient Greek and Latin language and literature, ancient history and epigraphy, Indo-European studies, and diachronic terminology.

Aikaterini Koroli is a papyrologist, philologist and linguist. She studied Greek philology at the University of Athens. She holds a master's degree in educational linguistics and a doctorate in classics and papyrology from the same university. The topic of her thesis, published in 2016, is the text-linguistic analysis of the act of requesting in private correspondence preserved on papyri and *ostraca* of the Roman, Byzantine and Early Arab periods of Egypt. From September 2015 to January 2019 she worked as a researcher with the Austrian Science Fund project *Texts and Textiles from Late Antique Egypt* (with Bernhard Palme and Ines Bogensperger) in affiliation with the Austrian Academy of Sciences. She currently holds a Hertha Firnberg Fellowship at the University of Vienna (project title: *Business Letters from Byzantine Egypt. First Edition and Linguistic Analysis of twenty five Greek Papyri*). Her publications so far deal with Greek papyrology, ancient and late antique Greek literature, text-linguistics, social and economic history, as well as the material culture of late antiquity.

Barbara Köstner is a textile archaeologist with a master's degree in archaeology of the Roman Provinces (main subject), Early Christian archaeology, ancient history and sociology (Universities of Cologne and Bonn). Her PhD project, *Complex Silk fabrics from the area of the Roman Empire from Late Roman and Early Medieval times*, examines different fabrics, such as taqueté and samite, in order to shed light on questions of the production, trade and consumption of these textiles. Her focus is on textile techniques and the transfer of fabrics and weaving technologies between Asia and Europe in Late Roman times. As a freelance textile archaeologist she has presented courses at universities and museums, where she endeavours to convey complex textile processes to students and audience thanks to her practical experience. In 2016, she was a Veronika Gervers Research Fellow at the Royal Ontario Museum, Toronto.

Anne Kwaspen trained as a textile artist and created contemporary textile artworks before beginning additional studies in tailoring techniques. For six years she worked for leading Belgian fashion designers, while training in textile conservation. As head of the Fashion Museum Hasselt she conveyed her knowledge of historical costume through exhibitions on fashion history. In 2007 she became conservator of Egyptian archaeological textiles at the Phoebus Foundation in Antwerp where she specialised in the technical analysis of textiles. Within the study of archaeological clothing finds, her previous work and experience bring an additional perspective in which the combination of technical analysis and the analysis of tailoring provides an insight on how the shape of garments has been established. She gained fieldwork experience as a textile specialist for the Brigham Young University, USA, excavation team working on textiles unearthed at Fag el-Gamus. In the coming years, she will conduct research on early medieval Egyptian tunics as a Marie Skłodowska-Curie Research Fellow at the University of Copenhagen, Saxo Institute – Centre for Textile Research.

Fleur Letellier-Willemin is a medical doctor and radiologist, a researcher in physical anthropology and a specialist in the field of X-ray use in archaeological research. She is an associate researcher with the CRIHAM EA 4270 team of Limoges University, and a member of the French archaeological team on the site of El-Deir, Kharga Oasis,

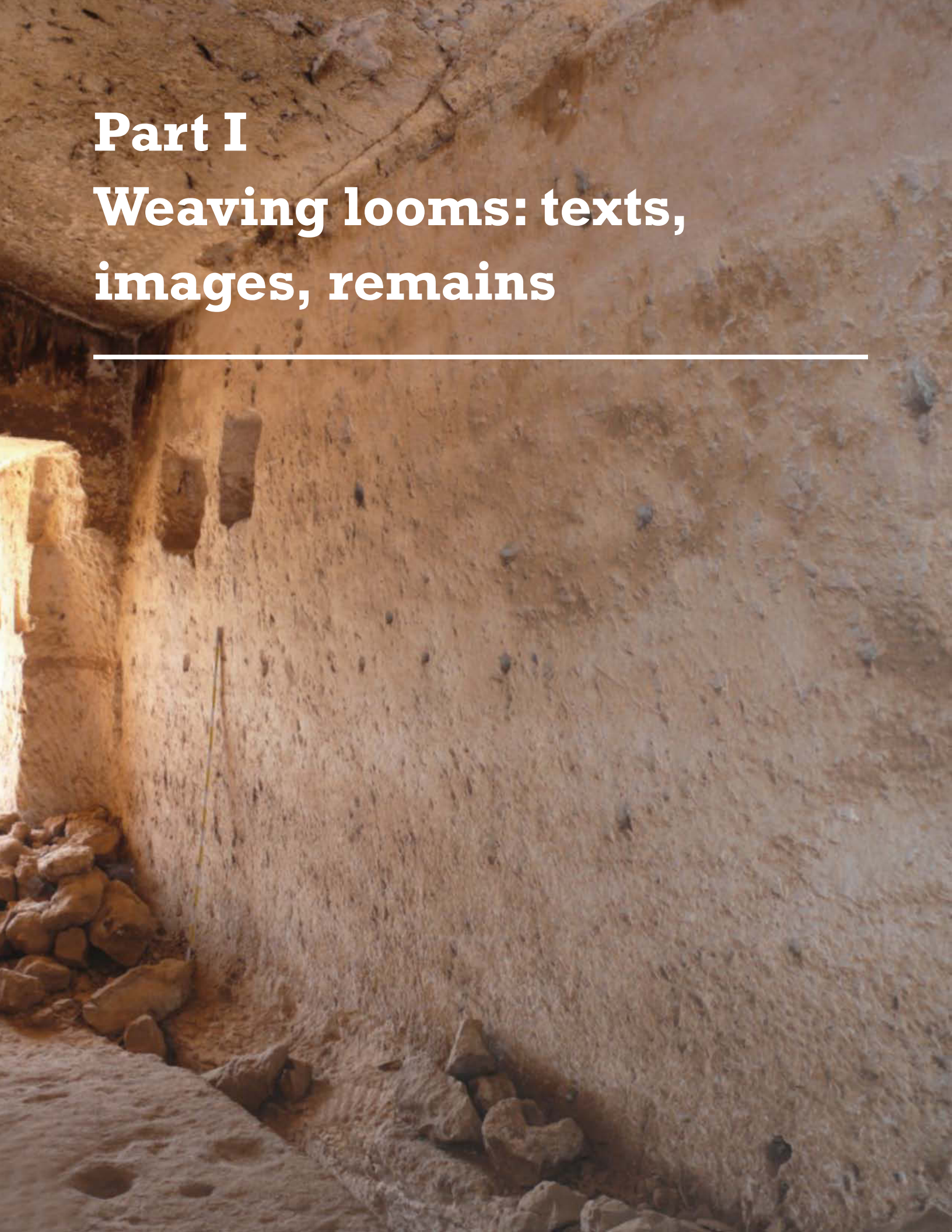
in Egypt's Western Desert where she is responsible for studying textiles found during excavations. She was also involved in the MAHES research programme (*Momies Animales et Humaines Égyptiennes*) at Montpellier University. As part of this project she studied textiles from animal mummies conserved at the Musée des Confluences, Lyon. She has also conducted research in physical anthropology with Jean-Louis Heim (Musée de l'Homme, Paris) and has X-rayed mummies in the field at El-Deir with Roger Lichtenberg.

Isabelle Marthot-Santaniello was trained in both classics and ancient history in Paris (Sorbonne) before focusing on Greek and, to a lesser extent, Coptic papyrology at the École Pratique des Hautes Études for her master's and PhD qualifications. A first post-doctoral post in the University of Minnesota introduced her to the field of digital papyrology. Since September 2015, she has been scientific collaborator in the Department of Ancient Civilisations at the University of Basel where she took part in the (re-)edition of the Basel papyrus collection (forthcoming *P. Bas.* II), and in the multidisciplinary research project *Change and Continuities from a Christian to a Muslim Society – Egyptian Society and Economy in the 6th to 8th centuries*. Since September 2018, she has been a leader of a project funded by the Swiss National Science Foundation and hosted at the University of Basel: d-scribes.org *Digital Palaeography of Greek and Coptic Papyri*. Her main fields of expertise are the edition and commentary of documentary papyri from late antique Egypt (4th to 8th centuries AD), the village of Aphrodito and, more recently, computerised approaches to ancient handwriting on papyri.

Maria Mossakowska-Gaubert, archaeologist and historian, is a graduate of the University of Warsaw. A former assistant curator at the National Museum of Warsaw, Department of Oriental Christian Art (1993-1999), from 1999 to 2003 she was an externally supported scientific fellow at the French Institute of Oriental Archaeology in Cairo (IFAO), then associate researcher at the IFAO. Since January 2017, she has been a Marie Skłodowska-Curie Post-Doctoral Fellow at the University of Copenhagen, Saxo Institute – Centre for Textile Research where she leads a project entitled MONTEX: *Monks, Nuns and Textiles: Production, Circulation, and Distribution of Textiles in the Monastic Environment in Egypt (4th-8th centuries AD)*. Her interests include various branches of material culture and different aspects of everyday life in Egypt in the Byzantine and Early Arab periods. Her current research focusing on textiles is conducted within the monastic context. These studies are interdisciplinary, combining Greek lexicographical research with archaeological data, as well as an investigation into social history with studies in the history of technology in ancient Egypt. A monograph based on her PhD dissertation, *Le vêtement monastique en Égypte (IV^{e}-VIII^{e} siècle)*, is forthcoming.

Helga Rösel-Mautendorfer studied Celtic studies at the University of Vienna. For her master's degree she worked on textiles from Hallstatt. She took part in the projects HallTexFWF–*Dyeing techniques of the prehistoric textiles from the salt mine of Hallstatt* (University for Applied Arts Vienna, Archaeometry Department) and HERA: CinBA–*Creativity and Craft Production in Middle and Late Bronze Age Europe* (Natural History Museum, Vienna). She has worked on reconstructions of Neolithic, Iron Age and antique garments for the Oberösterreichisches Landesmuseum, Linz. She has published various articles on archaeological textiles and experimental archaeology and collaborated in several exhibitions. Her main research interests are the textiles of prehistory and antiquity, textile techniques, in particular dyeing, experimental archaeology and reconstructions.

Johanna Sigl holds a PhD in egyptology from Ludwig-Maximilian University, Munich, concentrating on archaeozoology in the area of Aswan. Since her time as a master's student at the same university she has researched looms from Early Christian contexts in Egypt, using the excavated remains for reconstructions of the weaving apparatus of the first millennium AD. Since 2014 she has been a research fellow at the German Archaeological Institute (DAI) in Cairo, with responsibility for archaeological work on Elephantine Island as well as for departmental public relations. She is director of the research project *Realities of Life* investigating Middle Kingdom settlement structures through refined methods with a focus on reconstructing daily-life realities in the Pharaonic town of Elephantine around 1800 BC. In summer 2019 she took up the post of project coordinator for the DFG-funded project group *Entangled Africa* at the DAI's commission for Archaeology of Non-European Cultures in Bonn.



Part I
Weaving looms: texts, images, remains

A new kind of loom in early Roman Egypt? How iconography could explain (or not) papyrological evidence

Maria Mossakowska-Gaubert

The question of the different kinds of loom used in ancient Egypt is one of the most crucial issues to understanding the evolution of textile production and its technological development in the Nile Valley. However, sources concerning looms (archaeological, iconographic and written) from the Pharaonic era until the Arab medieval period are meagre, and many research questions remain open.[1] This article is an attempt at a new interpretation of some evidence, particularly iconographic and papyrological, which could add new data to the study of weaving looms used in Egypt of the early Roman period (1st–2nd century AD).

Looms in ancient Egypt – an overview[2]

The current state of research suggests that the horizontal loom, known as early as the Neolithic period, is the oldest type of loom used in Egypt. In this loom, the warp is mounted horizontally between two beams and is held in tension by pegs in the ground. The weaver kneels and has to move forward as the fabric progresses, either sitting beside the tissue, or perhaps on it.

It is generally considered that the vertical two-beam loom was introduced into Egypt during the New Kingdom and partly replaced the ground loom. In this loom the warp is held in tension between two beams fixed in an upright frame. According to Gillian Vogelsang-Eastwood's interpretation, the tension of the warp was controlled by turning or lowering a movable cross-beam.[3] The weaver was seated when starting, but as the work progressed, he/she had to stand in front of the loom.

It seems that in Roman times a new version of the two-beam loom appears in Egypt.[4] Analyses of archaeological textiles from Egypt, iconographic material from the western part of the Roman Empire,[5] as well as ethnographic evidence, have led Martin Ciszuk and Lena Hammarlund to conclude that the Roman two-beam loom had both beams

Published in Maria Mossakowska-Gaubert, ed., *Egyptian Textiles and Their Production: 'Word' and 'Object' (Hellenistic, Roman and Byzantine Periods)* (Lincoln, NE: Zea Books, 2020). doi 10.32873/unl.dc.zea.1079

1. For studies laying out the current state of research on this topic, see:
   Archaeological and iconographic evidence (from the Pharaonic to the Byzantine period): Kamp & Vogelsang-Eastwood 2001; Ciszuk & Hammarlund 2008; Sigl 2016; Sigl 2020.
   Papyrological documentation (Hellenistic and Roman periods): Wpiszycka 1965, especially p. 48–54; Droß-Krüpe 2011, especially p. 38–42.
2. See also the article by Johanna Sigl, in this volume (Sigl 2020).
3. Vogelsang-Eastwood 2000, p. 277–278; Kamp & Vogelsang-Eastwood 2001, p. 405–426, especially p. 413. However, M. Ciszuk and L. Hammarlund are more reserved about this issue and consider that "the depictions do not allow any secure conclusions about how the warp was mounted or the shedding mechanism constructed" (Ciszuk & Hammarlund 2008, p. 125).
4. I would like to thank Anne Kwaspen for discussing this topic with me and for her valuable technical remarks about the Roman loom.
5. Based mainly on John-Peter Wild's study (Wild 1992).

Figure 1a. Tunic found in a sarcophagus excavated at Sakkara in 1922, now preserved in the Egyptian Museum, Cairo (JE 59117), side B (2nd century AD). (Photo: Ahmed Amin © Egyptian Museum, Cairo).

revolving, and the warp fastened with a twined starting cord.[6] The weaver could be seated throughout the weaving process.

Following the results of Johanna Sigl's research,[7] one can suppose that at least from the 6th century AD a vertical loom, which use require a special pit, was known in Egypt. However, it has not yet been determined whether this loom had a simple warp, or a tubular warp (two-beam and/or three-beam loom): most likely, looms of various kinds were used in these 'loom-pits'.

As regards the warp-weighted loom, it was in use on sites where a non-Egyptian population was dominant: those founded by Greeks in the Ptolemaic period or constructed by the army during the Roman era. It could be also connected with the local production of cotton fabric – in Kharga and Dakhleh Oasis as well in Nubia, – the only regions in Egypt where cotton grew at least from the 2nd century AD.[8] In the warp-weighted loom, the warp is fixed to the upper beam and is held in tension by loom weights. The weaver works most of the time standing at the loom.

Finally, the tablet loom, well known during the Roman and Byzantine eras, has been already used in Egypt at the beginning of the 1st millennium BC, or perhaps even in earlier period.[9] It is small, ease to carry and can be set up anywhere.

It is obvious that at various epochs several kinds of weaving loom could be used simultaneously: the introduction of a new type of loom did not exclude the use of older loom models and versions.

The loom in iconography: missed evidence from Roman Egypt

It is surprising to note that the only representation of a loom identified until now from Roman Egypt does not

6. Ciszuk & Hammarlund 2008, p. 125. However, according to E. Broudy's interpretation, "the top beam of the Roman loom probably did not revolve but could be lowered though slots in the uprights as the weaving progressed and was wound on the lower beam" (Broudy 1979, p. 47).
7. Sigl 2016; Sigl 2020.
8. See especially Wild *et al.* 2008, p. 144. About cotton in Egypt see also Gradel *et al.* 2012, and the article by Fleur Letellier-Willemin, in this volume (Letellier-Willemin 2020).
9. Broudy 1979, p. 31.

Figure 1b. Tunic from Sakkara (JE 59117), side B: depiction of Isis weaving (detail). (Photo: Ahmed Amin © Egyptian Museum, Cairo).

Figures 2a and 2b. Sakata boy, Zaire, weaving raffia cloth using a footstrap loom. (Photos: Philippe Tits, member of Joseph Maes' mission to the Belgian Congo (1913-1914) © Royal Museum for Central Africa, Tervuren).

represent a two-beam loom, a ground loom, a warp-weighted loom, or even a tablet loom. Moreover, this evidence has never been cited in studies concerning weaving or, in general, textiles from Egypt.

The depiction of a loom is visible on a painted tunic found in Saqqara and dated probably from the 2nd century AD (fig. 1a).[10] One can recognize the goddess Isis sitting on a chair. As noted by Ewa Laskowska-Kusztal, and then Françoise Labrique, Isis is weaving: she passes thread with her left hand, and her left foot, placed on a support, seems to be attached to the warp (fig. 1b). E. Laskowska-Kusztal, and then Fr. Labrique, equated this unusual gesture with the action of a weaver from Niger: he is sitting on the ground and the tension of the warp is held by the back strap.[11] The weaver is operating the warp with his foot. However, this interpretation does not seem to be convincing: the gestures and posture of Isis are not the same as those of the weaver from Niger, and the position of the loom is completely different.

To find another parallel for the loom represented on the tunic from Sakkara, I have also resorted to ethno-

10. On this tunic, see especially Laskowska-Kusztal 1997 and Labrique 2015; cf. also Labrique & Papadopoulou 2012.
11. Labrique 2015, p. 218, fig. 1.

graphic material. It seems that the posture of Isis, as well as the loom construction, corresponds much better to the way of weaving on a foot-strap loom. This kind of loom can be seen, for example, in photographs of a Sakata boy from Zaire who is weaving raffia cloth (fig. 2).[12] In the foot-strap loom the warp is stretch between two parallel beams, the framework is set at an oblique angle, and the warp is kept in tension by the weaver with one or both feet. In this loom there is a single-heddle shedding device.

Looms in Roman papyrological evidence: an attempt at a new interpretation

Greek vocabulary concerning weavers and their looms attested in papyrological documentation from the Roman period is varied, and many of the terms and expressions are ambiguous.

Regarding the first two centuries AD, it is commonly admitted that the word γέρδιος is a general term for a weaver, and it has completely supplanted the term ὑφάντης used in the Ptolemaic period.[13] However, the term γέρδιος was already in use in the 2nd century BC[14] although we do not know the exact difference in meaning between the two terms.[15] It seems that the craft of specialised linen weavers, attested in Ptolemaic as well as in Roman times, and called λινύφος / λινόϋφος, λινοϋφικός, λινοπλόκος, βυσσουργός, was not connected to any specific loom, but rather to the way of weaving the warp threads which determines the look of textile.[16]

Regarding vocabulary connected to the loom, the word ἱστός in the Roman period keeps the ambiguity already attested in the Hellenistic period, and besides being a loom, it could specify a piece of textile, probably referring to its rectangular shape. Nevertheless, in many texts the term ἱστός is accompanied by other designations, such as γερδιακός, ἐνοίκιος, ἐπικάρσιος, or the context of the documents makes the meaning of word ἱστός more specific. In addition, some new specialised terms for the weaver's craft, especially γερδικὴ τέχνη and λινυφικὴ τῶν καθημένων τέχνη, are mentioned in apprenticeship contracts and they could be related to work on a specific loom.

Looms

ἱστός *(histos)*

Many sales agreements for looms were noted by the record office (*grapheion*) at Tebtynis (Fayyum Oasis) between AD 42 and 47. Seventeen of these contracts concern an ἱστός,[17] and one of them refers to an ἱστὸς γερδιακός.[18] However, it is not obvious if this distinction is deliberate and reflects different types of loom, or whether ἱστός is only a short version of the expression ἱστὸς γερδιακός.[19] These documents record administrative fees for sales agreements, but unfortunately do not provide any description of the looms. Whereas one of the contracts notes the price of an ἱστός as 24 drachmas,[20] another one concerns a contract "for nursing (a slave child) and for a loan of 12 drachmas and 2 *keramia* of wine, for a total of 16 silver drachmas. (Fee:) 4 obols. For this (loan), a loom (ἱστός) has been given as security".[21] It could therefore be supposed that the loom, referred to in this document as a guarantee, is worth at least 16 silver drachmas. The difference in price for the ἱστός indicated in the two documents is remarkable,

12. Picton & Mack 1989, p. 47 and 88.
13. Cf. Wipszycka 1965, p. 103; Ruffing 2008, p. 470–487; Droß-Krüpe 2011, p. 58–86.
14. For example, *P. Tebt*. I 16, 48 (2nd century BC).
15. Maybe the appearance of the term γέρδιος was connected with an increasing use in Egypt of a specific loom: the vertical two-beam loom? and the need to distinguish weavers working on this loom from other weavers, which used a ground loom and/or a warp-weighted loom? A lack of proof means that this interpretation remains hypothetical.
16. About these specialised weavers, cf. Wipszycka 1965, p. 103–110; Ruffing 2008, p. 466–468, 640–647; Droß-Krüpe 2011, p. 93–102.
17. *P. Mich.* II 123 *recto*, col II, 20, col. III, 19, col. VII 18, col. VIII 29, col. XI 5, col. XIV 12, 15, 26, col. XV 13, 24, col. XVI 10 (AD 45–46); *P. Mich.* II 125, 10 (AD 45); *P. Mich.* II 128, III 6, 21 (AD 46–47); *P. Mich.* V 240, 27, 41 (AD 46–47).
18. *P. Mich*. II 121 *verso*, col. VII, 3 (AD 42).
19. For this last option, see Wipszycka 1965, p. 52 and Droß-Krüpe 2015, p. 148. Nevertheless, because of all this ambiguity, the expression ἱστὸς γερδιακός will be presented in a separate chapter.
20. *P. Mich.* II 123 *recto*, col. XIV 26.
21. *P. Mich.* V 240, 64–65 (AD 46–47): English translation by the editors of this text: E.M. Husselman, A.E.R. Boak and W.F. Edgerton.

but we do not know if it is related to different kinds of loom, to their dimensions or perhaps to their condition.

ἱστὸς γερδιακός *(histos gerdiakos)*

Many papyrological documents refer to the sale or rent of a loom called ἱστὸς γερδιακός.[22] Some of them contain detailed description of the loom or its price. In the contract of sale of a loom to the weaver Tryphon from Oxyrhynchus, concluded in AD 54 (*P. Oxy*. II 264, 3), the seller Ammonios specifies "I agree that I have sold to you the weaver's loom (ἱστὸν γερδι[ακόν) belonging to me, measuring three weaver's cubits less two palms, and containing two cross-beams (ἀντία) and two upright beams (ἱστόποδες) and one ἐπίμιτρον".[23] This loom was sold for 20 silver drachmas.

A similar description of a loom is found in a rental contract (*P. Oxy*. XXXVI 2773, 11-14; AD 82): "I concede you the use of weaver's loom (ἱστὸς γερδιακός) which we possess measuring 3 cubits less 2 palms, comprising 2 cross-beams (ἀντία), 2 upright beams (ἱστόποδες) and one ἐπίμιτρον".[24]

The same kind of loom, but larger in size, is described in a sales contract dated to AD 101 (*P. Oxy.Hels*. 34, 2-9): "I agree that I have sold you the weaver's loom belonging to me, containing two cross-beams (ἀντία), two upright beams (ἱστόποδες), and one ἐπίμιτρον, the measurements of the two cross-beams being three and a half cubits for the one, and three cubits and ten digits for other".[25] This loom was sold for 28 silver drachmas.

Two terms that are used in the above descriptions of looms need a comment. The first one is ἀντίον, the word used in classical Greek texts for an upper cross-beam in the warp-weighted loom.[26] As Maarit Kaimio remarks in her publication of *P. Oxy.Hels*. 34, it seems probable that in the case of a two-beam loom "the lower beam also bore the same name".[27] Bernard P. Grenfell and Arthur S. Hunt, as well as Ursula Schlag, in their editions of the documents from Oxyrhynchus, had translated the term ἀντία as "rollers",[28] making, without doubt, a reference to the movement of the upper cross-beam in the warp-weighted loom.[29] This interpretation fits well with what we know about the Roman version of the two-beam loom with revolving beams. The meaning of the second term, ἐπίμιτρον, has been also analysed by M. Kaimio and she identified it in a convincing manner as a "heddle rod".[30]

M. Kaimio notes in her publication of *P. Oxy.Hels*. 34 that the measurement of the loom indicated in all these documents is probably the length of the cross-beams.[31] Although a calculation of the weaver's cubit used in the Roman period is still an open question, Antoine Pierre Hirsch in his PhD dissertation remarks, regarding cloth-weaver cubits mentioned in Ptolemaic and Roman period texts, that we do not know which cubit system was involved.[32] According to his interpretation of the metrological papyrus from Oxyrhynchus (*P. Oxy*. IV, 669; AD 285-287), the value of the weaver's cubit can vary from 37.5 cm to 43.75 cm.[33] So, we can approximately calculate the width of the looms mentioned in *P. Oxy*. II 264 and *P. Oxy*. XXXVI 2773 as between 97.5 cm and 113.75 cm. The cross-beams of the loom from *P. Oxy.Hels*. 34 had slightly different lengths: the first one between 131.25 cm and 153.12 cm, and the second one between 130.5 cm and 152.25 cm. Taking the dimensions of these looms into consideration, we can suppose that they were used to weave "Roman-style" tunics made of two rectangular pieces of fabric sewn together,[34] or to manufacture shawls, veils or furnishing textiles.

22. γερδιακὸς ἱστός in documents from the 1st and 2nd centuries AD: *P. Oxy*. II 367 (AD 25); *P. Mich*. II 121 *verso*, col. VII, 3 (AD 42); *P. Oxy*. XXXVI 2773 (AD 82); *P. Oxy*. II 264, 3 (AD 54); *P. Oxy.Hels*. 34 (AD 101); *P. Oxy*. III 646 (AD 117–138); *P. Oxy*. X 1269 (AD 101–125); *SPP* XXII 40 (AD 150).
23. Translation by editors B.P. Grenfell, A.S. Hunt (*P. Oxy*. II, p. 235) with my modifications.
24. Translation by editor U. Schlag (*P. Oxy*. XXXVI, p. 66) with my modifications.
25. Translation by editor M. Kaimio (*P. Oxy.Hels*. p. 127) with my modifications.
26. For example: Aristophanes, *Thesmophoriazusae*, 822.
27. *P. Oxy.Hels*. p. 128.
28. *P. Oxy*. II, p. 235; *P. Oxy*. XXXVI, p. 66.
29. Cf. Broudy 1979, p. 23–25; Ciszuk & Hammarlund 2008, p. 122.
30. *P. Oxy.Hels*. p. 128–129.
31. *Loc. cit*.
32. Hirsch 2013, p. 96.
33. *Ibid.*, table 23, p. 84. The weaver's cubit mentioned in *P. Oxy*. IV 669 contained most likely five palms, so depending on the cubit system, one palm equals 7.5 cm to 8.75 cm. One palm was divided in four fingers, from 1.8 cm to 2.1 cm.
34. About tunics used in Egypt at the Roman period, see Mossakowska-Gaubert 2017.

ἱστὸς τῶν ἐπικαρσίων *(histos tôn epikarsiôn)*

The expression ἱστὸς τῶν ἐπικαρσίων appears only once in the papyrological documentation (*P. Oxy.* XLII 3062, 3-4, 1st century AD) and it seems to be related to the manufacture of fabrics called ἐπικάρσια in documents from the Roman and Byzantine periods. The papyrological evidence of these terms has recently been studied by Kerstin Droß-Krüpe[35] and she concludes, in a convincing way, that textiles called ἐπικάρσια might be interpreted as "chequered garments", produced by any weaving technique. The ἱστὸς τῶν ἐπικαρσίων seems to be a special loom enabling the weavers to produce more complex types of check pattern fabrics, such as twill or diamond twill: according to K. Droß-Krüpe it was probably a two-beam loom with two or more shed sticks. We would add that it could also be a warp-weighted loom with three heddle rods.[36]

ἐνοίκιος ἱστός *(enoikios histos)*

The looms mentioned in the documents cited above were most likely used by professional weavers, however, looms were also used for domestic purposes. One of the documents from the Roman period (*P. Oxy.* XIV 1737, 8, 22, 42; 2nd–3th century AD) relates directly to a "house loom" (ἐνοίκιος ἱστός). It is not clear what kind of loom is referred to in this document, perhaps a simple ground loom?

The weaver's craft

γερδικὴ τέχνη *(gerdikê technê)*

In the Roman era documents we find numerous apprenticeship contracts (*didaskalikai* or *cheirographai*) for the "weaver's craft", γερδικὴ τέχνη.[37] These contracts contain detailed agreements concerning the financial conditions of training, accommodation etc., but they do not mention any type of weaving loom or other technical information about the skills to be learned. Most frequently the apprenticeship lasts from one to three years,[38] though some contracts concern a training period of four[39] or five years.[40] It seems that in the case of longer contracts, after two or three years of apprenticeship, a trainee became a journeyman to the master, and got a salary. It is not however clear why the duration of training is so variable. On the one hand, we have no proof that an apprentice learned only in one workshop, and on the other, it might be that he/she already had some weaving experience so his/her training could be shorter than that of a beginner. Nevertheless, it seems that three years was enough time for a basic training in the γερδικὴ τέχνη, and five years for becoming a specialised weaver. In comparison with other professional trainings, it seems a quiet long period,[41] which would be proof of high specialisation of the required skills.

λινυφικὴ τῶν καθημένων τέχνη *(linyphikê tôn kathêmenôn technê)*

A contract of apprenticeship (*cheirographon*) registered in *P. Fouad* 37 (AD 48), between a weaver named Menodorus and a certain Fuscus, concerns teaching, over two years "the craft of the seated linen weavers" (l. 4): [...] ἐγδιδάξαι τὴν λινυφικὴν τῶν καθημένων τέχνην [...]. The trainee is to receive payment during training of 48 drachmas each year.

In her book of 1965, Ewa Wipszycka was the first to pay attention to the exceptional feature of this document, clearly concerning some new technological concept.[42] She interpreted it as proof of the use of an improved version of the horizontal loom, probably with the raised pegs, allowing the weaver to sit when using the loom. She excluded the idea that this contract involved a two-beam vertical loom used since the Pharaonic period, because in the case of such a loom the weaver was seated only when starting the work. In addition, this loom had been known in Egypt from a long time, and it would not be necessary to specify in a contract that the weaver is sitting during a part of his/her work.

35. Droß-Krüpe, 2015, p. 149; Droß-Krüpe 2018.

36. About the technological possibilities of the use of warp-weighted looms, cf. Ciszuk & Hammarlund 2008, p. 122.

37. About apprenticeship contracts, see Bergamasco 1995, in particular for weavers: Wipszycka 1965, p. 57–63; Droß-Krüpe 2011, p. 103–120 (for an exhaustive list of contracts from the 1st to the 3rd century AD, see a table, p. 104–105).

38. Documents from 1st to 2nd century AD: *P. Tebt*. II, 384, 4–5 (AD 10); *P. Mich.* V, 346b-c (AD 12–13); *P. Oxy*. II 322 (AD 36) [= SB X 10236]; *P. Mich.* III, 170, 7 (AD 49), *P. Wisc*. I 4, 6 (AD 53*); P. Oxy.Hels*. 29 (AD 54); *P. Mich*. III 171, 11 (AD 58); *P. Mich.* III 172, 9–10 (AD 62); *P. Oxy.* II 275, 13 (AD 66); *P. Oxy.* XLI 2971 (AD 66); *SB* XXIV 16253, 9 (AD 97–103); *P. Tebt*. II 385 (AD 117); *SB* VI 9374 (AD 169).

39. *P. Oxy.* XIV 1647 (late 2nd century AD).

40. *P. Mich.* II 121, 2, VIII (AD 42); *P. Oxy.* IV 725 (AD 183).

41. Cf. Bergamasco 1995, see especially a table p. 162–166: he noticed only two cases of six-years training: for a physician as well as for a mason's craft.

42. Wipszycka 1065, p. 49–50.

Since 1965 many new sources and studies concerning weaving in Egypt have been published, but only Kerstin Droß-Krüpe, in her book of 2011 and then in her article from 2015,[43] has mentioned the contract recorded in *P. Fouad* 37. In her opinion, the weaver of this document is working on a two-beam vertical loom.

However, we can suppose that the expression λινυφικὴ τῶν καθημένων τέχνη used in *P. Fouad 37* means that the contract concerns another type of training, and probably another way of weaving and a different type of loom from that used in γερδικὴ τέχνη, so often mentioned in documents from the same period. It is obvious that the weaver working on the loom from *P. Fouad* 37 was always seated, but we do not know how and where: on the ground, a bench, a chair, or maybe in a pit? In addition, a salary for the apprentice is to be paid from the first year of training, which seems to be exceptional when compared with other weaver's apprenticeship contracts dated from the 1st century AD. Perhaps this weaving technique was not very complicated and an apprentice quickly became a journeyman.

Final remarks

Greek papyrological documentation from the 1st–2nd centuries AD features a varied vocabulary concerning weaving looms and specialised weavers. Some terms known in the Ptolemaic period disappear, but there are a lot of new ones. This differentiation of vocabulary seems to reflect technological developments and innovations in the domain of weaving.

The term ἱστός continues to be a general word for "loom", although it may sometimes take a specific meaning, most likely that of any vertical loom: a two-beam loom, without precision as to whether the beams are movable or not, and perhaps a warp-weighted loom also. It could be that the expression ἱστὸς γερδιακός, which appears in papyrological documents from the beginning of the 1st century AD, relates specifically to a vertical loom with moving beams. If a lexical distinction between the terms ἱστὸς γερδιακός and ἱστός mentioned in the documents from the record-office at Tebtynis is intended, in this case the term ἱστός was probably related to the "old version" of the two-beam loom. However, we have no data to be able to estimate the extent of the use in the early Roman period of both kinds of two-beam looms. Prices of two-beam looms mentioned in the documentation depended mainly on dimensions of the apparatus.

Another kind of loom also appears in the 1st century AD. This is the ἱστὸς τῶν ἐπικαρσίων, which was probably a vertical loom with a developed shed rods system, or a warp-weighted loom with three heddle rods, used to produce, for example, diamond twill. We can suppose that the simple horizontal loom, used mainly for domestic purposes in Egypt of the Roman period, was called ἐνοίκιος ἱστός. So far, we cannot identify any specific denomination for a warp-weighted loom, nor for a tablet loom, in the Greek vocabulary used in Egypt in the early Roman era.

The expression γερδικὴ τέχνη probably specifies the craft of a weaver working on any vertical two-beam loom. The lack of apprenticeship contracts concerning weavers specialised in one raw material, such as λινύφος / λινόϋφος, λινοϋφικός, λινοπλόκος, βυσσουργός, seems to prove that they worked on any kind of loom, most likely a vertical loom, and they received training in γερδικὴ τέχνη. However, apprenticeships in λινυφικὴ τῶν καθημένων τέχνη could be proof of the introduction into Egypt of a new kind of loom to produce linen textiles. It is tempting to connect the loom used by the "seated linen weaver" of *P. Fouad*. 37 with a foot-strap loom. This kind of loom could be identified in the representation on the tunic from Sakkara.

All identifications proposed in this article must remain hypothetical, but we hope that new data from papyrological, iconographical and archaeological sources will clarify the issue of looms used in Egypt in the Roman period.

Abbreviations

All papyrological works and all references to papyri, ostraca, etc. follow J.F. Oates, R.S. Bagnall, S.J. Clackson, A.A. O'Brien, J.D. Sosin, T.G. Wilfong & K.A. Worp (eds.), *Checklist of Greek, Latin, Demotic and Coptic Papyri, Ostraca and Tablets*. Available at: https://library.duke.edu/rubenstein/scriptorium/papyrus/texts/clist_papyri.html (continually updated)

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43. Droß-Krüpe 2011, p. 40–41; Droß-Krüpe 2015, p. 148.

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Egyptian pit-looms from the late first millennium AD — attempts in reconstruction from the archaeological evidence

Johanna Sigl

Introduction

In discussions on the development of weaving technology, specifically treadle looms in the Mediterranean area, Egypt is often referred to as one of the earliest countries in which people used foot-powered looms for producing cloth. It is thought to have been in regular use in the production of cloth as early as the second half of the 1st millennium AD.[1] This belief is built on results from excavations undertaken during the early 20th century by the Egypt Exploration Fund at the hill of Sheikh Abd el-Qurna in Luxor,[2] as well as on textile studies.[3] Unfortunately, none of the postulated looms has ever been found and no pictorial evidence has survived illustrating the apparatus that the weavers worked on. Texts provide only scant information, none of which is sufficiently descriptive.[4] For the reconstruction of the weaving device used in Egypt during the Late Roman and Early Islamic periods one therefore depends on the scarce archaeological and architectural information from excavations. This consists predominantly of pits,[5] which were identified by Herbert E. Winlock[6] as substructures of a horizontal treadle loom. However, Winlock's identification was criticised by various researchers,[7] and subsequently his suggestion was disproved by the experimental reconstruction of a loom within one of the pits of the monastery of Epiphanius, as well as the comparison with more recent archaeological evidence.[8] Although Winlock was with much certainty correct in proposing that the pits were once loom emplacements,[9] the type and features of the weaving apparatus are still uncertain.

Published in Maria Mossakowska-Gaubert, ed., *Egyptian Textiles and Their Production: 'Word' and 'Object' (Hellenistic, Roman and Byzantine Periods)* (Lincoln, NE: Zea Books, 2020). doi 10.32873/unl.dc.zea.1080

1. Zhao 2001, p. 213 following Carroll 1988, p. 37–38.
2. Winlock & Crum 1926, p. 67–69.
3. *E.g.* Carroll 1985, p. 169–171.
4. *E.g.* Crum & Evelyn White 1926, p. 247: no. 352
5. Few other parts of looms have been discovered, and even fewer in context with one of the pits in question. The finds excavated in close proximity to the pits are warp spacers (in the *laura* of Cyriacus, see Bechtold 2007, p. 56–57, or in Deir el-Bakhit, DB 2414+DB 2417 see in J. Sigl in Sigl & Tatz in prep.), and weaving combs (in Deir el-Bakhit, DB 2700? and DB 298 see in J. Sigl in Sigl & Tatz in prep.). However, these tools can be used in several types of weaving apparatus.
6. Winlock & Crum 1926, p. 68.
7. White 1962, p. 173; Wild 1987, p. 459; el-Farag 1983, p. 54; Verhecken-Lammens & de Jonghe 1993, p. 61; Huber 2006, p. 63, note 5.
8. J. Sigl in Sigl & Tatz in prep.
9. Apart from H.E. Winlock's loom emplacement hypothesis, which in its outlines is adopted here to similar longitudinal pits in the floors of the North Tombs of Tell el-Amarna, three other suggestions for the use of these installations were made independently: two by N. de Garis Davies (1903, p. 12–13 and note 1) and one by F. Kampp-Seyfried (1995, p. 214, note 28). All of them can be ruled out because of the triviality of their reasoning (Sigl 2008, p. 355–361; Sigl 2011, p. 19–20).

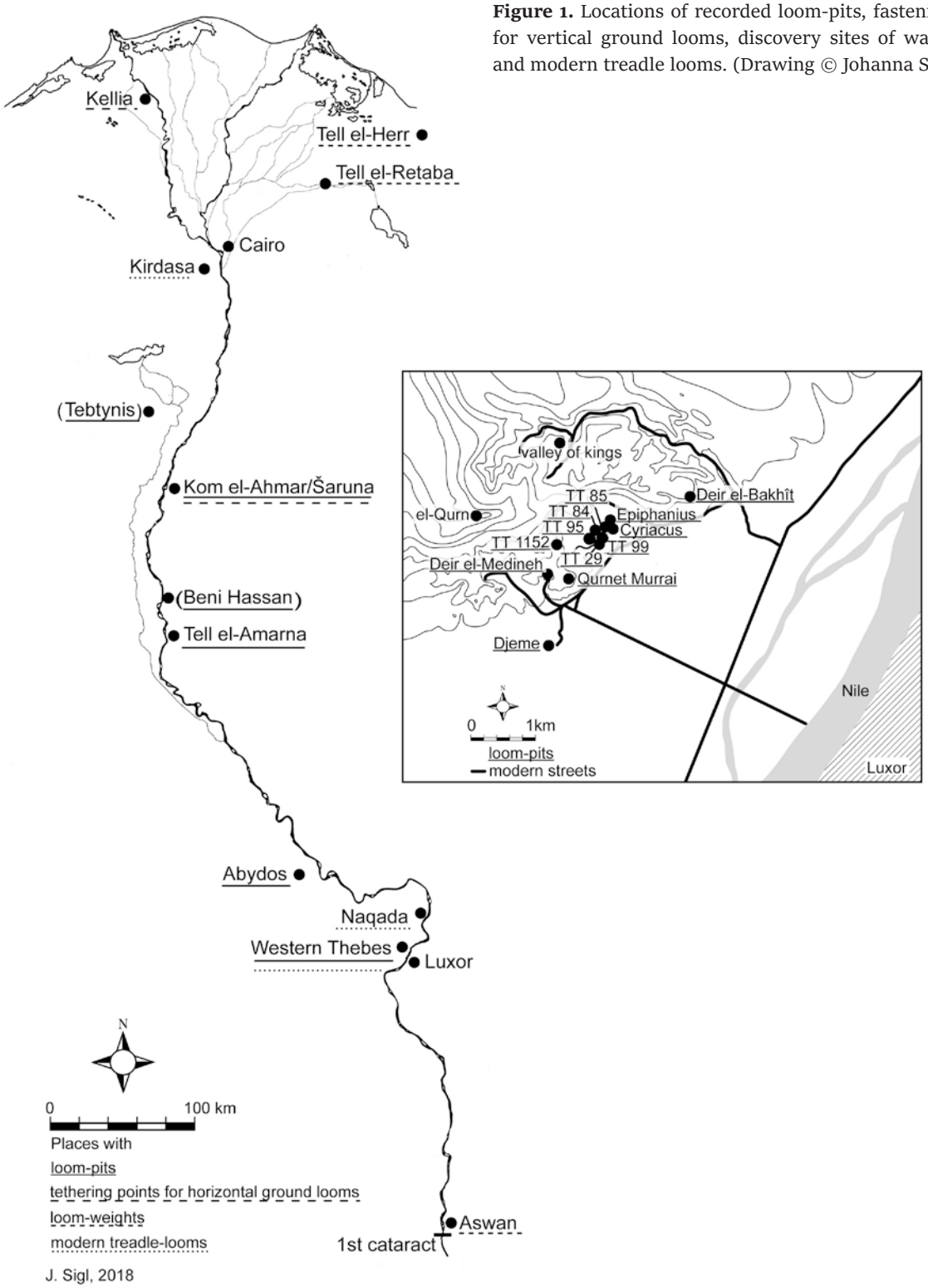

Figure 1. Locations of recorded loom-pits, fastening devices for vertical ground looms, discovery sites of warp-weights and modern treadle looms. (Drawing © Johanna Sigl, 2017).

Loom-pits: the archaeological evidence

The author has thus far been able to compile 53 examples of so-called loom-pits, all situated in Upper Egypt, mostly in Western Thebes (fig. 1). Eleven further structures (in Table marked with '??' in column 'no.') are mentioned in publications, where their existence could not be verified on plans, pictures or on site so far, and as such their

identification in itself is not certain.[10] Otherwise, they have been found during excavations and look overall very similar to the pits in question, but differ in their chronological context and specific details.[11] The precise dating of the securely identified features is difficult but can mostly be attributed to the re-use of Pharaonic structures in the late 1st millennium AD.[12] The overwhelming majority of cases suggest a Christian occupation with monastic activity taking place. Additionally, the pits display the following similarities (Table):

- no other part of the weaving instrument apart from the pit has survived to the present day;[13]
- all pits were set parallel to a wall[14] – a fact N. de Garis Davies had already noted for the pits in the North Tombs at Tell el-Amarna;[15]
- their shape is longitudinal and their size exceeds 150 cm in length, in most cases;[16]
- in the best preserved examples, crossbars of wood were installed near either end and the bottom of the pit. In many of the less well-preserved examples the holes for their installation can still be seen.

There are only four types of loom that can be considered as once having been installed in the pits, primarily because they were either used in Egypt during earlier periods, or proposed to have been in use by the 1st millennium AD: furthermore, because they are suitable for weaving cloth of the size for tunics or shrouds.[17]

The treadle loom has been suggested, as mentioned above, which was in use in China by the 2nd century BC.[18] However, it is not clear when it was introduced into the Mediterranean region. The first pictorial evidence of this kind of loom comes from Europe and dates to the 13th century.[19] Contemporary finds of early medieval pit treadle loom emplacements,[20] which have been attested to 1st

10. In the publication of the monastery of Epiphanius, Winlock mentions eight pits, but only seven are depicted in his plans (Winlock & Crum 1926, p. 67). In the contribution on the monastic structure of Qurnet Murai five pits are mentioned, but only three are distinguishable in the published plans, while the identification of the other three in the represented structures is uncertain (Castel 1991, p. 2042; J. Sigl in Sigl & Tatz in prep.); in plans of the tombs BH 3 and BH 23 in Beni Hassan, structures might be identified as loom-pits, but an *in situ* verification is still to be done (J. Sigl in Sigl & Tatz in prep.). In TT 84 a pit in the first hall of the tomb, directly left of the entrance, is too badly preserved into an older structure to be called a loom-pit (author's own observations with the kind permission of A. Gnirs-Loprieno and the local inspectors of her excavation project (2017); J. Sigl in Sigl & Tatz in prep.); in the tombs at Kom el-Ahmar/Sharuna depressions were identified as feeding troughs, but could also be seen as crude loom-pits with 'crossbars' made of stone (J. Sigl in Sigl & Tatz in prep.).
11. At the French excavations in Tebtynis several pits have been found that feature the same oblong shape, but the crossbar is inserted in additional depressions near each end and runs parallel to the length of the overall pit. Apart from this instance, these structures date to Ptolemaic times (information kindly provided by G. Hadji-Minaglou (2015 and 2018); J. Sigl in Sigl & Tatz in prep.) and it is therefore uncertain if they are loom-pits at all.
12. For a discussion on the date of installation of the loom-pit in TT 99, see Strudwick 2011, p. 376–379. In Deir el-Bakhit the pits were put in place during the main occupation phase of the monastery during the 7th to 9th centuries AD (Beckh 2013, p. 55).
13. Only tools that could be used on any kind of loom were found. These are remains of warp spacers and weaving combs, spindles, needles, pin beaters, etc. (for example J. Sigl in Sigl & Tatz in prep.; Huber 2006, p. 67; Huber 2007, p. 66–68).
14. There are a small number of exceptional cases: the pit in TT 95 was situated near a column, which in this case could have served the same purpose as a wall (cf. J. Sigl in Sigl & Tatz in prep.); next to some of the pits in the monastery of Cyriacus round depressions in the floor could have served as fixtures for vertical beams, against which the loom could have leant (cf. Bechtold 2007, figs. 1, 4 and 5).
15. De Garis Davies 1903, p. 12.
16. Shorter examples are found at the monastery of Cyriacus (cf. Table; Bechtold 2007, figs. 1 and 4).
17. The use of these looms for *keiriai*, as Winlock suggested (Winlock & Crum 1926, p. 68 and 71), is very unlikely, because it would not make economic sense to use such a wood and space-consuming apparatus for an item that can be woven on a small table loom.
18. Zhao 2001, p. 471–472, fig. 117.
19. Trinity College Museum 0.9.34 fol. 32b, Cambridge, Great Britain (Carroll 1988, p. 34–36, fig. 10).
20. Windler 2008, p. 209–212.

millennium AD contexts in Egypt, differ considerably from the installations discussed here. Today the standard type of pit treadle loom, which is known throughout the whole of North Africa, uses a similarly narrow roundish treadle emplacement to the medieval European one.[21] There is no connection, either in time or location, to the pit-loom we are searching for. Furthermore, experimental reconstruction following the initial description of H.E. Winlock, and taking into account the construction of the mentioned modern pit-looms, proves that a foot-powered loom could not have been installed within the pits in question.[22]

Weaving looms used in ancient Egypt: a typology[23]

In Pharaonic Egypt weaving involved two kinds of looms. The older one is the horizontal ground loom, which is shown in both model form and in tomb paintings.[24] Evidence for the use of this type of loom was found in Early Christian contexts at Kom el-Ahmar/Sharuna[25] and in the hermitages of Kellia.[26] Some of these constructions might have been used for mat weaving rather than cloth.[27] On the other hand, looms similar to the ancient Egyptian types are still in use for textile weaving in Africa and the Near East, especially by nomadic groups.[28] However, these s are never connected with any pit construction. They are therefore not the weaving devices we are searching for.

By the New Kingdom a vertical frame loom is depicted in tomb paintings instead of the ground loom.[29] A quite complex reconstruction of this loom is given by Herbert G. Farbrother in Barry J. Kemp and Gillian Vogelsang-Eastwood's publication of the textile industry at Tell el-Amarna.[30] Simpler kinds of vertical looms have been in use not only in ancient Greece and the Near East, but continue to be used up until the present day in the same areas as well as in many regions of Africa.[31] In Syria/Palestine and amongst some African tribes a kind of vertical frame loom installed over an oblong pit is known.[32] Thus, this kind of weaving apparatus could be an answer to the question about the Egyptian pit-loom, an issue I will return to below.

After the 21st Dynasty there are no further images of looms known from Egypt, however, at the same time the so called warp-weighted loom was in use in ancient Greece. In some cases the warp length was extended by standing the weaving apparatus over a pit.[33] This type of loom was introduced during the Late Period into Egypt. Warp weights have been found at excavation sites that can

21. Examples from North and East Africa: Schädler 1987, p. 84, fig. 16 and p. 400–401, figs. 614–616; and the author's own observations in Egypt since 2005 (locations cf. fig. 1).
22. J. Sigl in Sigl & Tatz in prep.
23. See also the article by Maria Mossakowska-Gaubert, in this volume (Mossakowska-Gaubert 2020).
24. For example: model from TT 280, Cairo JE 46723, Egypt, 3rd millennium BC (Winlock 1955, p. 31–33, 88–89, pls. 25–27, 66, 67); wall painting in tomb of Khnumhotep II, Beni Hassan No. 3, Egypt, 2nd millennium BC (Roth 1913, p. 3–7), etc.
25. Information kindly provided by B. Huber (2010). See as well Huber 2006, p. 63–64.
26. Long-bones of big mammals inserted in facing walls and building a rectangle: Qusur el Iseila: Hermitage no 14, room 11(?) and 16; Hermitage no 45, room 16 finale phase of 7th century; Hermitage no 156, room 7 (Makowiecka 1986, p. 107–112; Makowiecka 1999, p. 26 and plan 1 fig. 2, plan 3 figs. 10 and 11, plan 4 figs. 19 and 20, plan 13 fig. 156, plan 14 fig. 168, plan 15 fig. 174, plan 24 figs. 422, 424 and 429, plan 25 fig. 439).
27. Makowiecka 1986, p. 107–112; Makowiecka 1999, p. 26.1
28. Schädler 1987, p. 56–65.
29. For example: wall painting in tomb of Thotnefer, TT 104, Egypt, 2nd millennium BC (Shedid 1988, p. 128, pl. 5a, 27); *talatat*-block from Amarna, Malawi Museum, Egypt, 2nd millennium BC (Messiha & Elhitta 1979, p. 24, pl. XXXI: 586); etc.
30. Kemp & Vogelsang-Eastwood 2001, p. 405–426.
31. For example: relief of Nerva, Rome, Italy, 1st century AD (von Blanckenhagen 1940, p. 124, pls. 40–42); wall painting in the hypogeum of Aureli, Rome, Italy, 3rd century AD (Himmelmann 1975, p. 22–23, pls. 6, 7); book painting, University of Utrecht 32 fol. 84b, Netherlands, 9th century AD (Walton Rogers 2001, p. 164, fig. 19.5a); book painting from Eadwine or Cantabury, Trinity College Library R. 17.1 fol. 263, Cambridge, Great Britain, 12th century AD (Walton Rogers 2001, p. 164, fig. 19.5b); modern looms: Schädler 1987, p. 65–70.
32. Syria/Palestine: Crowfoot 1941, p. 141–151; Stærmose Nielsen 1999, fig. 73B (my thanks to M. Mossakowska-Gaubert for pointing out the latter publication to me). Africa: Picton & Mack 1979, figs. 41 and 60.
33. Depiction on an urn from Sopron (Ödenburg), Hungaria, Naturhistoric Museum, Vienna, Austria, 1st century BC (Barber 1991, p. 55, 92, 106, figs. 2.15, 13.3); pits and loom-weights in palace of Tilleda, Germany, 10th century AD (Grimm 1969, p. 97–99, pl. 13).

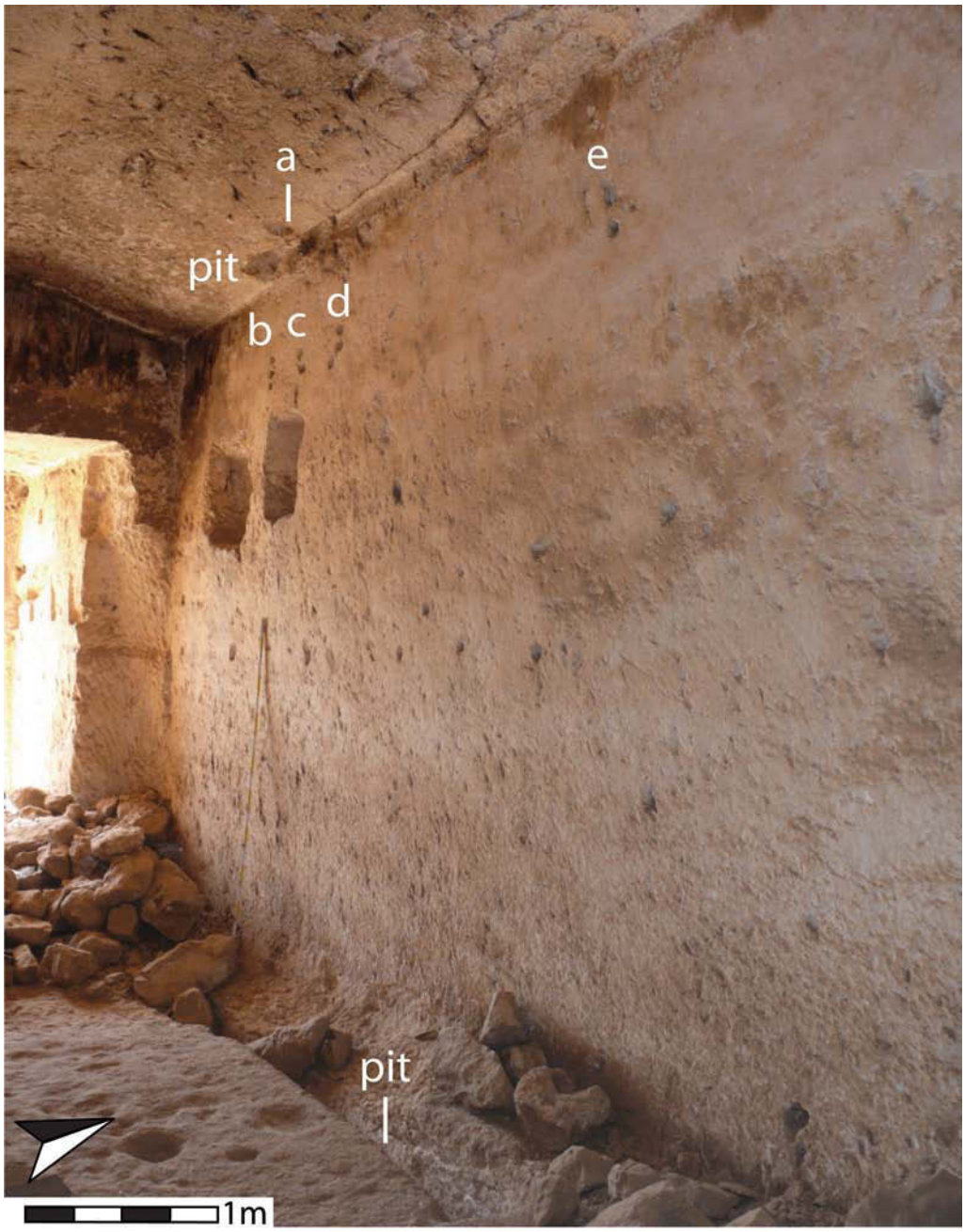

Figure 2. Pits in floor and ceiling, and tethering points in TA 3B, Tell el-Amarna North Tombs. (Photo © Johanna Sigl, 2009).

be attested to military contexts or to the homes of foreigners living in Egypt.[34] Not a single weight for weaving has been found in context with the type of pits under discussion in this article. Apart from this, the warp-weighted loom is usually associated with societies where wool is the dominant weaving fibre. Linen is, on the contrary, the dominant fibre in ancient Egypt. This material can only be woven on a warp-weighted loom with some difficulty because of its smooth surface.[35] Despite the fact that wool was used a great deal in Egypt during the 1st millennium AD, this loom is in my opinion not the one we are searching for.

34. Warp-weights found in Tell el-Herr: Valbelle 1998, p. 809 and fig. 6. Warp-weights from Tell el-Retaba: Rzepka *et al.* 2008, p. 134 and 138–140; Rzepka *et al.* 2010, p. 258 and 265–266; Warp-weights from the excavations in Syene/Aswan: Sigl 2017, p. 48, 129 and 145; information kindly provided by W. Müller (2010, 2013 and 2014); von Pilgrim *et al.* 2011, p. 137–140.

35. Tietzel 1988, p. 14.

Pit-looms: attempts at reconstruction

Therefore, the only loom that is left as a possible solution is the vertical frame loom. Important proof of vertically constructed weaving apparatuses first appeared during the study of two loom-pits located in the North Tombs at Tell el-Amarna,[36] TA 3B (fig. 2) and TA 3C, thereafter from information provided by Nigel Strudwick[37] on a pit in TT 99 in Western Thebes, and thirdly, from the most recent re-evaluation of installations in TT 84 by Andrea Gnirs-Loprieno.[38] These tombs not only contain pits in the floor, but grooves were also cut into the ceiling directly above pits at ground level (fig. 2). The side beams of the loom were most probably locked between the pits in the floor and the ceiling and the whole construction thus kept it from tilting. A tethering point in the rim of the upper pit in TA 3B (fig. 2: a) might have been used to fix the whole apparatus or secure the upper weaving beam further. Additional hoops were found in the walls behind the pits in TA 3B (fig. 2: b–e) and 3C (Table). As these anchor points (fig. 2: b and e) are in line with the ends of the pits carved into the floor and ceiling in both tombs, it is possible that the side beams of the loom had been fixed here as well.[39] On the western side of TA 3B, three instead of one of the anchor points were recorded (fig. 2: b–d); could this be an indication that the left beam was moved for some reason, *e.g.* to weave smaller or wider cloth? Inside the pits no further sign was found that the side beam had been altered in its position. The additional hoops may also have had to be cut because the pit itself was extended towards the west when the loom no longer exceeded the requirements of the weaver. Unfortunately, both assumptions cannot be proven due to the poor state of preservation of the pits and no preserved cloth from the same context. Furthermore, in none of the other recorded examples are similar fixtures attested. In most cases no roof or walls of these rooms are preserved: the pit in the corner of the pillared hall of TT 85 was built underneath a natural hole in the ceiling of the tomb;[40] the interior of TT 95[41] is too poorly preserved to allow any useful information on any fixtures above ground level; in TA 1 the conservation work in the ceiling looks as if it would cover a groove at the edge of the eastern wall, but due to its filled in state it remains uncertain as to whether it really existed; all other examples are situated outside of former tombs and survive with no roof and only partly preserved walls (Table). On the other hand, in the Abydos pits, corbel blocks for square beams were installed over each of the small ends of the trenches (Table).[42] The side-beams of a loom inserted into such mounts would have been held very tight, not allowing for any movement. These blocks could therefore be seen as a better version of the tethering points than TA 3B and 3C in Amarna.

Apart from the clues mentioned above, there is further evidence for an argument that a vertical loom was in use. One major characteristic of the pits from Western Thebes (*e.g.* Deir el-Bakhit, Room 25, northern loom-pit: fig. 3) and Abydos were wooden crossbars fixed close to the bottom of the pit near each narrow end. In most cases the bars are not preserved, however, holes used to fix them in the sides of the pits can be attested (Table). In most loom-pits examined by the author, there is evidence that two bars had been installed, never one, and a single example of four bars can be seen in the case of loom-pit A from the monastery of Epiphanius. In some pits the bars were found *in situ*.[43] Remains of rope were still wrapped around several of them[44] and constriction marks led to the suggestion that a part of the loom had been firmly attached to the staffs. But the question remains as to which part? In a vertical frame it could have been the side beams, which were tied to the crossbars. The bars and ropes would have kept the loom frame steady, preventing reduction of the space between the side beams.[45] The same function can be

36. Sigl 2011, p. 8 and 12.

37. Information kindly provided by N. Strudwick (2010); Strudwick 2011, p. 376–379.

38. Project *Life Histories of Theban Tombs* see https://lhtt.philhist.unibas.ch/ (last checked: 20/08/2017).

39. See modern fixation of side beams on a loom from Africa: Picton & Mack 1979, fig. 2.

40. Author's own observation and information kindly provided by H. Heye (2005).

41. Information kindly provided by A. Gnirs-Loprieno (2005).

42. el-Farag 1983, figs. 1, 2, 3A and pl. 9: a and c.

43. *E.g.*: Monastery of Epiphanius, loom-pit A (Winlock & Crum 1926, pl. XXI: B); Deir el-Bakhit, storage room, northern loom-pit (own observation); TT 85, forecourt, loom-pit near Coptic house, loom-pit next to tomb entrance (information kindly provided by H. Heye, 2004).

44. Sigl 2008, p. 361, fig. 2.

45. Examples that could disproof this theory are the mud floors of the pits in the monastery of Deir el-Bakhit which neither in the room 25 nor in room 44 show no abrasions, while at the same time such damages should be anticipated if a heavy object like a loom stood on them and even moved slightly during its use. On the other hand in some of the pits at Tell el-Amarna round or square depressions in the curves of the oblong pits seem to have been installed to hold in place a vertical positioned beam (cf. Sigl 2011, p. 16–17).

suggested for tethering points found at the bottom of two pits in Kom el-Ahmar/Sharuna, formerly identified as feeding troughs (Table).[46] These binding devices not only have nearly the same position in the pits as the crossbars, but would also be used to compensate for a higher amount of drag.[47] However, since no sign of usage wear of the mud plastering around the crossbars in the pits, which were mud lined, could be observed, this solution remains questionable. Similarly the edges of the pit, where those side beams could have been placed following the example of the modern Syrian/Palestine looms,[48] *e.g.* in the storage room in Deir el-Bakhit, do not show any signs of wear or destruction. Alternatively, one could suggest that the whole construction worked without side beams, but used a hanging upper weaving bar[49] and a floating lower bar, between which the tension of the warp was adjusted by roping or releasing the binding of the lower beam down to the crossbars in the pits.[50] This, however, would render the aforementioned ceiling pits in some of the tombs in Tell el-Amarna and at Sheikh Abd el-Qurna useless.

As mentioned above, a possible solution to the question about the late 1st millennium loom maybe the weaving apparatus from Syria and Palestine described by Grace M. Crowfoot.[51] This vertical two-beam loom was also set up above a longitudinal pit in the floor. From photos in the publication,[52] it looks like the loom's side beams stood on the floor next to the pit. The frame was leant in an angle against a wall or roof. The upper and lower weaving beams were fixed to the side beams and a third beam was set a certain distance behind the frame to elongate and tighten the warp.[53] Could the tethering points in the walls of TA 3B (fig. 2: b–e) and 3C in Amarna have held such a third weaving beam? An argument against this possibility can be seen in the closeness of the installations to the walls, especially when taking into account the slightly angled position of a frame, when it was locked between the pits in floors and ceilings. Beams fastened to the hoops could in this case have been used to tighten the threads, but surely not to elongate them. A further counterargument is the high setting of the tethering points. If one follows the working method of the Syria/Palestine loom, the third beam has to be released at intervals to be able to move the warp around the loom.[54] However, if the floor level in the tombs of Tell el-Amarna at the time when the weaver used it had been the same as in the Pharaonic period, he would have had to climb onto something to perform this task making the procedure a great deal more difficult. The first interpretation, where the tethering points are used as a means to fix the side beams, therefore, seems more suitable given the present state of knowledge.

The way in which the warp was guided around the weaving beams might furthermore be used as an indicator for the loom. In Crowfoot's Syria/Palestine examples, the warping is tubular with a turning rod.[55] Thus, when the cloth is finished, the turning rod can be removed and the start and end border of the cloth will show loops where it once fitted. However, such loops could not be identified in the few samples of cloth that had been sufficiently preserved from Deir el-Bakhit. On the contrary, the scarce examples of visible cloth endings showed open fringe threads.[56] It is therefore more likely that weaving took place on one plane only.[57]

46. Schenkel & Gomaà 2004, pls. 156: a, 157: a, and 158: c.
47. Why three such bails had been installed in one of the troughs (Table) cannot be answered. It may have been used as an extra means to fix the loom, also at its lower weaving beam.
48. Crowfoot 1941, pl. XII, 1 and XIII.
49. *E.g.* see modern looms from Africa: Broudy 1993, figs. 3–25; Schädler 1987, figs. 86–88.
50. Similar to looms from Gabun or Tandjua, Lac Mai-Ndombe, depicted by K.-F. Schädler (1987, p. 67, fig. 12 and p. 69, fig. 80).
51. Crowfoot 1941, p. 141–151; Chr. Verhecken-Lammens and D. de Jonghe also suggested a vertical two-beam loom to be the apparatus on which a child's tunic they studied had been woven: Verhecken-Lammens & de Jonghe 1993, p. 61.
52. Crowfoot 1941, pl. XIII.
53. *Ibid.*, p. 142.
54. *Loc. cit.*
55. *Ibid.*, p. 142–143.
56. S. Tatz in Sigl & Tatz in prep.
57. Of course, the loops could have been cut open as well or the warp was wrapped tubularly without a turning rod (see Kemp & Vogelsang-Eastwood 2001, fig. 9.4a-d). See a parallel for a possible pit-loom with weaving done on one plane only: Picton & Mack 1979, figs. 54–56.

Figure 3. The northern loom-pit of Room 25 in Deir el-Bakhit with a seat for a single person on the northern (left) side and one *in situ* crossbar at the eastern (far) end of the pit. (Photo: Ina Eichner © DAI Cairo / LMU Munich, 2005).

Figure 4. The eastern loom-pit of Room 25 in Deir el-Bakhit with a seat for more than one person on the eastern (right) side and one *in situ* crossbar at the northern (far) end of the pit. (Photo: Ina Eichner © DAI Cairo / LMU Munich, 2005).

Aside from what has been considered thus far, not every single pit might have held the same type of loom, and the position of the weaver is one of the best indicators for this point. While this loom is definitely close to a wall and could either seat one (fig. 3) or more persons (fig. 4) in the case of the loom-pits at Deir el-Bakhit,[58] there is not enough space to seat the weaver(s) between wall and trenches in the cases of TA 3B (fig. 2), 3C, and in TT 84, TT 99 (Table). Unfortunately, an installation indicating the seat of the weaver can be reconstructed in only a few cases. Features such as an extension on the side across from the wall in the pit in the forecourt of TT 29 cannot as yet be fully explained.

Final remarks

In summary, the actual loom, which had once been set up in the longitudinal pits recorded in Western Thebes, Abydos, Tell el-Amarna, Kom el-Ahmar/Sharuna and possibly in Beni Hassan and Tebtynis, will remain the object of much speculation due to the low state of preservation. The loom from Syria/Palestine described above might not be the exact parallel, but at the moment it seems to be the closest possible solution. As mentioned, various kinds of construction, for example an alteration between floating beams and a strong frame construction might also be possible. Only with the recording of additional examples of these pits and of the surrounding archaeological remains of the late 1st millennium AD, amongst which actual parts of the loom might be found, is there any possibility of answering the riddle of the pit-loom used in Egypt.

58. J. Sigl in Sigl & Tatz in prep.

Table: Loom-pits collected by the author since 2005 (**l** = length (min. –max.); **w** = width (min. –max.); **d** = preserved depth (min. –max.); **cb.**= cross-bar; **cbh**.= crossbar holes (in pairs); **tb.**= tethering point; **cs.** = corbel stone for beam(?); **cp.**= ceiling pit; **N** = north; **E** = east, **S** = south, **W** = west; **?** = no data available; **??** = uncertain identification)

- Deir el-Bachît: author's own observations (2005–2006); Sigl 2007; Eichner *et al.* 2009; Sigl 2016; J. Sigl in Sigl & Tatz in prep.
- Monastery of Epiphanius: Winlock & Crum 1926, p. 68–71; J. Sigl in Sigl &Tatz in prep. Revised seat-position for the loom-pit in cell A near entrance, E side: ~~seat~~ = Winlock & Crum 1926; seat = J. Sigl 2010: because of the similarity to the seat-installations in Deir el-Bakhît.
- Laura of Cyriacus: Winlock & Crum 1926, p. 68–71; J. Sigl in Sigl & Tatz in prep.; Bács, 2000; Bechtold 2007.
- Qurnet Murrai: Castel 1979; Castel 1991; J. Sigl in Sigl & Tatz in prep.
- Deir el-Medineh: Bruyère 1948, p. 48, pl. 6; J. Sigl in Sigl & Tatz in prep.
- TT 29: Information provided by L. Bavay (2005–2006); Tefnin 2002; Boud'hors & Heurtel 2002; Bavay (2007–2008; J. Sigl in Sigl & Tatz in prep.
- TT 84: Information provided by E. Grothe (2005) and A. Gnirs-Loprieno (2017); Gnirs *et al.* 1997; J. Sigl in Sigl & Tatz in prep.
- TT 85: Information provided by H. Heye (2005); Gnirs *et al.* 1997; J. Sigl in Sigl & Tatz in prep.
- TT 95: Information provided by A. Gnirs-Loprieno (2005); Gnirs *et al.* 1997; J. Sigl in Sigl & Tatz in prep.
- TT 99: Information provided by N. Strudwick (2010); Strudwick 2011; J. Sigl in Sigl/Tatz in prep.
- TT 1152: Information provided by I. Antoniak (2005); Author's own observations (2005); Górecki 2013, p. 185; J. Sigl in Sigl & Tatz in prep.
- Medinet Habu/Djeme: Hölscher 1934, pl. 34: I4; Hölscher 1954, p. 57–61, figs. 60–61; J. Sigl in Sigl & Tatz in prep.
- 'Weaving factory'/monastery of Mousa: identification of the building complex by Ayman Mohamed Damarany, 19.02.2014, *Tell!-lecture* series at German Archaeological Institute Cairo; el-Farag 1983; J. Sigl in Sigl & Tatz in prep.
- TA 1: de Garis Davies 1905b, pl. I.; Sigl 2011, p. 360–362; J. Sigl in Sigl & Tatz in prep.
- TA 2: de Garis Davies 1905a, p. 33, pl. XXVIII; Sigl 2011, p. 362; J. Sigl in Sigl & Tatz in prep.
- TA 3B: de Garis Davies 1905a, p. 3, pl. XLIV; Sigl 2011, p. 363–365; J. Sigl in Sigl & Tatz in prep.
- TA 3C: de Garis Davies 1905a, p. 3–4, pl. XLIII; Sigl 2011, p. 366–368; J. Sigl in Sigl & Tatz in prep.
- TA 3: Sigl 2011, p. 368–370; J. Sigl in Sigl & Tatz in prep.
- TA 4: de Garis Davies 1903, p. 12–13, pl. I; Sigl 2011, p. 370–373; J. Sigl in Sigl & Tatz in prep.
- TA 5: de Garis Davies 1906, pl. I; Sigl 2011, p. 373–374; J. Sigl in Sigl & Tatz in prep.
- BH 3: Newberry & Fraser 1893b, pl. XXII: plan: shaft B and cross-section A-B plus pl. XXIII: fig. 2; J. Sigl in Sigl & Tatz in prep.
- BH 23: Newberry & Fraser 1893a, pl. XXIII: plan: close to N wall of chamber; J. Sigl in Sigl/Tatz in prep.
- Deir el-Qarabin: Information provided by B. Huber (2010); Huber 2006, p. 63–64; Huber 2007, p. 66–68; J. Sigl in Sigl & Tatz in prep.
- V23: Schenkel & Gomaà, 2004, Pl. 156: a (two structures in room in northeastern edge of forecourt), 157: a (in the foreground), 158: c.
- Umm el-Breigât (Tebtynis): Information provided by G. Hadji-Minaglou (2015 and 2018); J. Sigl in Sigl & Tatz in prep.

location		position	Dating	no.	L (cm)	W (cm)	D (cm)	dist. from wall (cm)	wall–pit–seat relation	fixations				
										cb.	cbh.	tp.	cs.	cp.
Western Thebes	Deir el-Bakhit	room 25, N wall	7th–9th c. AD	1	225	40	88	0	[wall] (seat) (pit)	1	2	0	0	0
		room 25, E wall	7th–9th c. AD	1	200	37	92	0	[wall] (seat) (pit)	1	2	0	0	0
		room 44, E wall	7th–9th c. AD	1	200	35	62–69	0	[wall] (seat) (pit)	1	2	0	0	0
		room 44, S wall	7th–9th c. AD	1	240	23	77	0	[wall] (seat) (pit)	1	2	0	0	0
	monastery of Epiphanius	TT 103, portico, S of pillar S of entrance	6th–7th c. AD	1	200	35	95–100	50	[wall] (extension) (pit)	5	4	0	0	0
		TT 103, forecourt, E of monastery entrance C	6th–7th c. AD	1	190	15–20	60	60	[wall [recess] wall] (extension) (pit)	1	1?	0	0	0
		cell A, entrance, E side	6th–7th c. AD	1	225	25	60	70	[wall] (seat) ~~seat~~ (pit)	0	0	0	0	0
		cell A, corridor, W side	6th–7th c. AD	1	230	30	?	70	[wall] (extension) (pit)	?	?	?	?	?
		cell C, longitudinal hall	6th–7th c. AD	1	?	?	?	?	[wall] ? (pit)	?	?	?	?	?
		cell C, longitudinal hall	6th–7th c. AD	1	?	?	?	?	[wall] ? (pit)	?	?	?	?	?
		cell C, longitudinal hall	6th–7th c. AD	1	?	?	?	?	[wall] ? (pit)	?	?	?	?	?

location	position	Dating	no.	L (cm)	W (cm)	D (cm)	dist. from wall (cm)	wall–pit–seat relation	fixations				
									cb.	cbh.	tp.	cs.	cp.
laura of Cyriacus	?? (=TT65, near Paser-wall?)	6th–7th c. AD	1??	?	?	?	?	?	?	?	?	?	?
	TT 65, near Paser-wall	6th–7th c. AD	1	187	43	40	?	[wall] [seat?] (extension) (pit)	1	?	0	0	0
	TT 65, forecourt	6th–7th c. AD	1	150	45	10	?	no walls in vicinity; no seat discernible	0	0	0	0	0
	TT 65, forecourt	6th–7th c. AD	1	140	45	25	?	no walls in vicinity; no seat discernible	1	?	0	0	0
	TT-NN-24, forecourt, S of oven	6th–7th c. AD	1	110	30–55	80	?	no walls in vicinity; no seat discernible	0	0	0	0	0
	TT-NN-24, forecourt, near above mentioned one	6th–7th c. AD	1	110	30–55	80	?	no walls in vicinity; no seat discernible	0	0	0	0	0
	TT-NN-24, forecourt, near above mentioned one	6th–7th c. AD	1	100	35	50	?	no walls in vicinity; no seat discernible	0	0	0	0	0
TT 29 (Frange)	forecourt, middle, near 'Coptic wall'-remains	8th c. AD	1	176	24	87	0	[wall] (pit) (extension)	1	1	0	0	0
TT 84	forecourt, S half	1st mill. AD: Christian	1	155	32	50	?	no walls in vicinity; no seat discernible	1	2	0	0	0
	first hall, N of entrance to second hall	1st mill. AD: Christian	1	200	>20	50	40	[wall] (shaft) (pit) (shaft)	1	1	0	0	1
	first hall, S of tomb entrance	1st mill. AD: Christian?	1??	200	?	20	?	[wall] (extension) (pit) (extension)	0	0	0	0	1?
TT 85	pillar hall, SW edge, S wall	1st mill. AD: Christian	1	180	20–36	>14	35–40	[wall] (pit) ?	1	1	0	0	0
	forecourt, outside of 'Coptic building', E wall	1st mill. AD: Christian	1	190	36	50	0	[wall] (pit) ?	1	1	0	0	0
	forecourt, W half, near entrance, S wall	1st mill. AD: Christian	1	228	52–58	40	0	[wall] (pit) ?	2	2	0	0	0
	forecourt, SW edge, S wall	1st mill. AD: Christian	1	?	?	30–45	0	[wall] (pit) ?	1	0	0	0	0
	forecourt, S half of W wall	1st mill. AD: Christian	1	?	25	?	30	[wall] (pit) ?	0	0	0	0	0
TT 95	pillar-hall, near wall remains near pillar H	1st mill. AD: Christian	1	176	26	39	?	no walls in vicinity; no seat discernible	1	1	0	0	0
TT 99	first hall, N of entrance to second hall	?	1	250	60	15	0	[wall] (pit) ?	0	0	0	0	1

location		position	Dating	no.	L (cm)	W (cm)	D (cm)	dist. from wall (cm)	wall–pit–seat relation	fixations				
										cb.	cbh.	tp.	cs.	cp.
	TT 1152 (watch tower)	forecourt, W half, N wall	6th–7th c. AD	1	?	<20	?	?	[wall] (pit) ?	2	2	0	0	0
		?	6th–7th c. AD	1	?	?	?	?	?	?	?	?	?	?
	Qurnet Murrai	working room, S wall	6th–8th c. AD	1	180	30	?	30	[wall] (pit) (extention)	2	2	?	?	?
		working room, W wall	6th–8th c. AD	1	140	30	?	30	[wall] (pit) ?	2	2	?	?	?
		working room, N wall	6th–8th c. AD	1	210	40	?	30	[wall] (pit) ?	1	1	?	?	?
		SE cell, W wall	6th–8th c. AD	1	200	45	?	60	[wall] ? (pit??)	1	1	?	?	?
		? (corridor, N wall)	6th–8th c. AD	1??	230?	20?	?	30?	[wall (extension??) (pit??)	?	?	?	?	?
		?	6th–8th c. AD	1??	?	?	?	?	?	?	?	?	?	?
	Deir el-Medineh	'Coptic structure' W of temple, E wall	1st mill. AD: Christian	1	220	40	?	0	[wall] (pit) ?	2	2	?	?	?
Abydos	'weaving-factory'/monastery of Mousa	great pillar room, W half of N wall	7th–8th c. AD	1	165	90 incl. ext.	330	0	[wall] [extension] [pit] ?	0	2	0	?	0
		great pillar room, E half of N wall	7th–8th c. AD	1	165	90 incl. ext.	330	0	[wall] [extension] [pit] ?	0	2	0	1	0
		great pillar room, N half of E wall	7th–8th c. AD	1	165	90 incl. ext.	330	0	[wall] [extension] [pit] ?	0	2	0	2	0
		great pillar room, S half of E wall	7th–8th c. AD	1	165	90 incl. ext.	330	0	[wall] [extension] [pit] ?	0	2	0	?	0
		great pillar room, E half of S wall	7th–8th c. AD	1	165	90 incl. ext.	330	0	[wall] [extension] [pit] ?	0	2	0	2	0
		great pillar room, W half of S wall	7th–8th c. AD	1	165	90 incl. ext.	330	0	[wall] [extension] [pit] ?	0	2	0	2	0
		great pillar room, S half of W wall	7th–8th c. AD	1	165	90 incl. ext.	330	0	[wall] [extension] [pit] ?	0	2	0	2	0
		great pillar room, N half of W wall	7th–8th c. AD	1	165	90 incl. ext.	330	0	[wall] [extension] [pit] ?	0	2	0	?	0
Tell el-Amarna	TA 1	pillar hall, E wall, N end	1st mill. AD: Christian	1	276–293	14–45	36–48	20	[wall] (pit) ?	0	0	0	0	?
	TA 2	pillar hall, E wall, N end	1st mill. AD: Christian	1??	300	60	>100	20	[wall] (pit) (extension)	0	0	0	0	0

location		position	Dating	no.	L (cm)	W (cm)	D (cm)	dist. from wall (cm)	wall–pit–seat relation	fixations				
										cb.	cbh.	tp.	cs.	cp.
	TA 3B	longitudinal hall, W wall, S half	1st mill. AD: Christian	1	244	20	5	30	[wall] (pit) ?	0	1?	5	0	1
	TA 3C	longitudinal hall, W wall, middle	1st mill. AD: Christian	1	282–293	22–30	21–40	30	[wall] (pit) ?	0	1?	2	0	1
	TA 3	forecourt, 'Coptic structures' in W half, N wall	1st mill. AD: Christian	1	231–268	20–33	23–30	65	[wall] (stoneledge) (pit) (extension)?	0	2?	0	0	0
	TA 4	forecourt, E half, N wall	1st mill. AD: Christian	1	284	20	13	30–40	[wall] (pit) (pit) ?	0	0	0	0	0
		first hall, E wall, N end	1st mill. AD: Christian	1	257–258	7–12	20–25	80	[wall] ? (pit) ?	0	2	0	0	0
	TA 5	longitudinal hall, S side, E end	1st mill. AD: Christian	1	291–298	12–21	30–38	40	[wall] (pit) ?	0	1?	0	0	0
Beni Hassan	BH 3	pillar hall, S wall, middle	1st mill. AD?	1??	230	40	30	15	[wall] (pit) ?	?	?	?	?	?
	BH 23	pillar hall, N wall, middle	1st mill. AD?	1??	195	38	?	25	[wall] (pit) ?	?	?	?	?	?
Kom el-Ahmar/Saruna	Deir el-Qarabin	room 10, E wall	till 7th–8th c. AD	1	350	40–55	45–50	40	[wall] (pit)	1	2	0	0	0
	V 23	forecourt, 'Coptic building' in NE edge, N wall	till 7th–8th c. AD	1??	320	40	30	20	[wall] (pit??) seat	0	0	2	0	0
		forecourt, 'Coptic building' in NE edge, W wall	till 7th–8th c. AD	1??	360	70–75	45	0	[wall] (pit??) seat	0	0	3	0	0
Umm el-Breigât (Tebtynis)	*thesauros*	storage room?	late Ptolemaic, 2nd c. BC	1??	295	50	>70	?	[wall] ([cb.] pit [cb]) ?	2	2	?	?	?
	?	?	late Ptolemaic, 2nd c. BC	1??	?	?	?	?	[wall] ([cb.] pit [cb]) ?	?	?	?	?	?

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Part II
Technology of weaving: study cases

Tackling the technical history of the textiles of El-Deir, Kharga Oasis, the Western Desert of Egypt[1]

Fleur Letellier-Willemin

The site of El-Deir is situated north of Kharga in the "Great Oasis" of the Egyptian Western Desert (fig. 1).[2] The site was occupied between the 6th century BC and the 6th century AD. A complex history emerged with the influence of many cultures: Persian, Greek, Roman and early Christian. Archaeological finds in both El-Deir and the oasis itself (the site of Dush and the temple of Darius in Hibis, a city north of Kharga) confirm that the Great Oasis was a wealthy region.[3] This is also substantiated by texts from Ain Manawir and Dakhleh.[4] The presence of an artesian aquifer, a great economic asset, further underpinned the prosperity of the area, which was a crossroads for numerous routes from the earliest dynasties.[5]

The specific nature of textiles from El-Deir

There are currently three different sources of textiles on the site (fig. 2): the six cemeteries (five polytheistic and one Christian), the workshop of the embalmers, and the Roman fortress with adjacent temple. Most of the textiles have been found in a funerary context.

The study of the textiles takes place within an oasis, a circumscribed setting with a specific geography and climate, and over a long continuous period. Such conditions are favourable for emphasising traditions and changes.

Before briefly mentioning the material from El-Deir, we feel it is important to underline that comparisons with other textile studies are difficult. The majority of the necropoleis of the site are Ptolemaic and very few studies have concentrated on this period. In consequence, any possible comparisons must be made with recourse to Pharaonic textiles. On the other hand, the examples of textiles retrieved from the soundings in the fortress can be easily placed due to studies conducted in the Eastern Desert. Likewise, material from the Christian cemetery finds parallels in the numerous sites in Egypt that date to the Byzantine era.

Technical and aesthetic criteria of the textiles from the site are important for the study of the social status of the buried individuals and provide an assessment of the local standard of living. The study of textiles can also help in reconstructing, at least partially, the textile industry of the oasis. Textiles can also shed new light on religious, cultural and economic life. Lastly, they can serve as a comparative tool for other sites.

How does one deal with the diversity and quantity of textiles found in such a specific oasis site? Four hundred pieces of textile were selected in the field, entered into a

Published in Maria Mossakowska-Gaubert, ed., *Egyptian Textiles and Their Production: 'Word' and 'Object' (Hellenistic, Roman and Byzantine Periods)* (Lincoln, NE: Zea Books, 2020). doi 10.32873/unl.dc.zea.1081

1. The textile study of El-Deir is part of the French multidisciplinary mission to El-Deir, led by Dr Gaëlle Tallet, University of Limoges.
2. Wagner 1987, p. 124–128 and 131–134.
3. Reddé 1992; Hope & Whitehouse 2003; Agut & Moreno 2016, p. 520.
4. Chauveau 1996 ; Agut-Labordère 2014.
5. Tallet *et al.* 2012; Guédon 2012, p. 62–63.

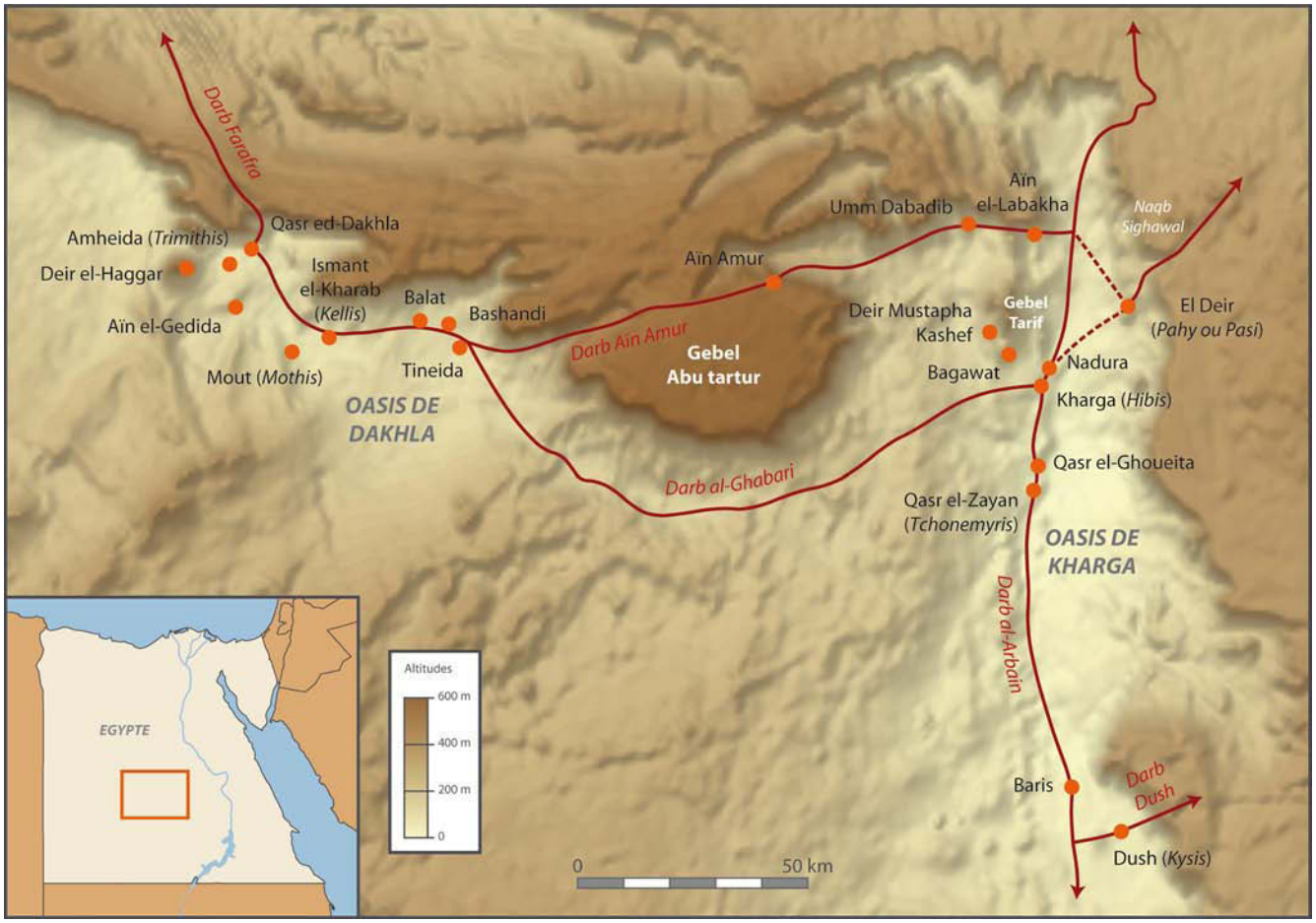

Figure 1. The Great Oasis: crossroads (Drawing © Mission archéologique d'El-Deir/ANR OASIS).

Figure 2. North, East and the so-called "Piton aux chiens" cemeteries: general view (Photo: Fleur Letellier-Willemin © Mission archéologique d'El-Deir/ANR OASIS).

database and then analysed. An essential step in the first instance was to choose, on-site, representative textiles according to quantity and quality, archaeological context, per individual, per tomb or *en masse*. These were in the great majority mere fragments, the site having been looted many times in the not too distant past. Once the textiles had been sorted, the second step involved a technical examination stretching from fibre to fabric, in order to shed light, for each, on the characteristics, the techniques used to transform them and, when possible, the tools used to do so.

Only a few examples, which illustrate the diversity of the site, will be presented in this article, while focus shall remain on the raw material. We have chosen to present, one by one, the three textile fibres found on the site: linen, cotton and wool.

Linen

Linen textiles were present everywhere on the site but most were found in the polytheistic cemeteries during of the examination of the human and dog mummies. These cemeteries are from the Ptolemaic period but they were used until the end of the 3rd century AD, perhaps even during the 4th century AD. Traditional Egyptian linen is very plain. The quality of the thread and the quality of the weaving are immediately noticeable in a plain cloth with little or no decoration. The Egyptian reference textile since the first dynasties is based upon a linen cloth of high quality thread and weaving.

The linen fibres from the site of El-Deir are generally long and regular. Only a few coarse textiles have been found and they have short and coarse threads.

Some undyed textiles appear as if they were flecked, a rare characteristic. The darkest fibres are completely unprocessed whereas the brightest fibres are rather decomposed and less ligneous. This was the result of a specific technical choice, although not limited to El-Deir since we also find such textiles elsewhere in the Nile Valley.[6]

The threads always present an S-twist. We cannot give statistics on splicing or spinning at El-Deir even if spinning easily predominates. Plied threads, with two S2s yarns, are not so rare.[7] Different categories of threads are defined by their regularity, diameter and twisting. The most common threads (about 44%) have a diameter between 0.3 and 0.5 cm, with an average twist of around 45 degrees. A few rare threads are 0.2 cm in diameter, which could mean they were made using a different process.[8] The usual differences between warp and weft are respected although, sometimes, some weft yarns display a very high amount of twisting, more than the warp. This can be regarded as a choice because in traditional textiles (warp-faced tabbies) the warp was considered to be the strongest thread.[9]

The weaving shows only tabbies. In number, plain tabbies predominate very largely, followed by basket weave, then half-basket and balanced finally with a few rare tabbies with "floated threads". Knots are very often found in the weft and sometimes in the warp. Their number reflects the quality of the threads and/or the experience of the weaver with only a few errors noticed. The most frequent errors are short weft floats, which could suggest the use of a ground loom.

Another key characteristic of the flax from El-Deir is the density of the threads. The most common density is around 22 to 28 warp yarns per centimetre and eight to 12 weft yarns per centimetre. Textiles with 40 warp yarns per centimetre are not so rare. There are also a few textiles (bandages and shrouds) with 60 warp yarns per centimetre on human and dog mummies. A small quantity of coarse textiles was found as stuffing.

The selvedges are always plain and most of them are regular which means the weaver was experienced. Some selvedges are tightly packed to produce ribbing, another technical point. The so-called "Piton aux chiens" cemetery is where a bandage with a special funerary weaving of its two selvedges was found. It is the only one on the site and might belong to someone in the higher ranks of society.

The borders show different weavings made with different tools and thus are very important to identify. We can distinguish two categories: borders without fringes and borders with fringes (fig. 3). Weaving techniques may be different to produce each of them. For example, a border with fringes can be the beginning and end, or only the end, of a textile made on a horizontal or on a vertical two-beam loom.

When present, fringes reflect a fashion. For instance, a large quantity of textiles with long diverse fringes was found in the cemetery south of the site, whereas many woven looped fringes were found in the cemetery on the north side.

The study of hems underlines the use of Z2s threads. Many of them are carefully rolled. We can find different well-known, "classical", sewing patterns. One of them should be highlighted: it is used on the shoulders of Roman

6. Huber 2015, p. 18–19.

7. Kemp & Vogelsang-Eastwood 2001, p. 59.

8. Cook & Brennan 1990, p. 9.

9. Oral communication with J. P. Wild & S. Desrosiers. I thank them very much.

Figure 3. Border with uncut warps: linen (Photo: Fleur Letellier-Willemin © Mission archéologique d'El-Deir/ANR OASIS).

two-part tunics,[10] which have a special herringbone stitch. We have seen a few repairs, darning or patching: they are carefully sewn. The most frequent dimensions of the complete tabbies are about 1 x 1 or 1 x 2 metres, which recalls the royal Egyptian cubit (52.50 cm).[11] Bigger tabbies were found in the north-east cemetery: one, incomplete, with warp threads of more than 4 metres and a complete example with two borders of which the warp threads are more than 3 metres (similar to textiles from the tomb of Wah, Middle Kingdom).[12]

Patterns can be sorted into four categories:

- made during warping: for example, blue stripes. To make stripes (warp) and not bands (weft), blue longitudinal warp threads must be set. Several textiles decorated with blue stripes are held in the Metropolitan Museum of Arts (e.g. MMA 07.316.46.6, MMA 90.5.102);
- made during warping and weaving: for example, check-patterned linen textile (half-basket). To make checks one needs coloured warp and coloured weft;
- made during the weaving: with classical undyed self-bands (there are also some openwork and weft patterns similar to chain-like patterns that are sometimes discontinuous) (fig. 4);
- made after the weaving: with cords sewn on borders (neck-openings for example) and with painting on several shrouds.

Most of the linen textiles are undyed but we can find coloured textiles in various shades of brown, red, yellow, orange, pink, black-brown, blue and green-blue (fig. 5). This implies that there were different dyes and different dying techniques.[13] Analyses of the dyes have not yet been conducted for reasons outwith our control, but it is possible to say that we are dealing with mineral and vegetal dyes. Kharga Oasis supplied ochre and alum (Dominique Cardon mentions Kharga as a source of alum,[14] while Alfred Lucas and J.R. Harris state that ochres come from the western oases[15]). Some rare whitish fragments appear to have been intentionally bleached.

Many linen shrouds were found in the Christian cemetery. They all have similar dimensions to those of the polytheistic cemeteries (2 x 1 metres approx.), plain selvedges with the same patterns, simple cut fringes, openwork made by the lack of wefts, additional coloured woollen wefts and two or four "medallions" in the corners made with coloured woollen looped wefts. Up to 11 newly made linen shrouds can be used to wrap a mummy. The quality of flax used to produce them is different from that of the shrouds from the Ptolemaic and Roman tombs. It is of lower quality with irregular threads and low twisting, although the weaving is good. Few linen fragments of high quality were, however, found in the Christian cemetery.

10. About tunics used in Egypt in the Roman period, cf. Pritchard 2006 and Mossakowska-Gaubert 2017.
11. About cloth-weaver cubit, see Hirsch 2013, p. 86–97.
12. Kemp & Vogelsang-Eastwood 2001, p. 324–335.
13. Cardon 2003, p. 80, and 356.
14. *Ibid.,* p. 29.
15. Lucas & Harris 1962, p. 236.

Figure 4. Pattern with openwork: linen (Photo: Fleur Letellier-Willemin © Mission archéologique d'El-Deir/ANR OASIS).

Figure 5. Dyed linen fabrics: samples (Photo: Fleur Letellier-Willemin © Mission archéologique d'El-Deir/ANR OASIS).

We have also found narrow bands (warp-faced tabby, basket or balanced tabby). Incidentally, the weaving of narrow bands is described in some texts from the Theban area and dated from the beginning of 8th century AD. These were woven by monks on narrow looms.[16]

The linen textiles from other parts of the El-Deir site are plain weave with few colours and little decoration. It is worth remarking that one fragment of linen found in the fortress was dyed in green and red. This is a very significant example that corresponds to another textile and cultural context. Red is a difficult colour to obtain on this material and to do so required a particular dying technique, which only appeared in Egypt during the Roman period. This fragment is associated with some woollen tassels as well as a small fragment of reversible *taqueté*, which leads us to link these textile novelties from the fortress to those of the Eastern Desert.

Cotton

We found cotton everywhere we dug and the most important questions are: where does it come from and when was it made? Ten samples have been dated using ^{14}C method: the oldest is from the 1st century BC and the most recent from the 4th century AD.

The origin of the cotton is complex and, in the case of Kharga Oasis, probably multiple, within a very different context than the Eastern Desert. The knowledge of cotton may have been acquired by the people of the oasis from merchants and travellers moving along the caravan routes out of Sudan and Nubia.[17] Research into the cultivation and use of cotton in Egypt is in progress. We should mention here the "revised ideas" on Egyptian cotton presented by John-Peter Wild, Felicity Wild and Alan J. Clapham,[18] as well as studies on cotton textiles from Kellis by Rosanne Livingstone,[19] Nubian cotton textiles by Elsa Yvanez,[20] papyrological documentation published by Rogel S. Bagnall,[21] and a recent publication the Nord Kharga survey textile material by Jana Jones.[22]

All cotton fragments are plain tabbies, weft faced, with reinforced bundled selvedges, thus they are in fact woven in the same way as wool in the Greek tradition, on a warp-weighted loom. According to the studies presented by Wild, Wild and Clapham, the presence of the warp-weighted loom in the oasis seems to be connected with local cotton production.[23]

Cotton fibres from El-Deir are spun with a hard irregular twist and irregular diameters. The twist is always S. We find many errors, mainly weft floats, but a few weaves are quite regular, tightly packed and with a high density (fig. 6). The quality of the spinning and of the weaving depends on the quality of the fibres, the tools and the experience of the weaver working with a "new" fibre. Cotton thread can also be used for sewing, hemming, darning and patching, even on linen and woollen textiles.

Cotton is used in some other techniques, such as pile fabrics (fig. 7), with symmetrical knots (Ghiordes).[24] These knots are also used as a discontinuous pattern.

One piece of textile presents a very particular cotton weave. It is of very good quality with three different patterns, like *crêpe*. We have noticed this in woollen scarves from the Christian cemetery. It implies the weaver was extremely experienced.[25]

We have also found cotton textiles in the padding of mummies from polytheistic cemeteries and incomplete cotton shrouds in the Christian cemetery. Some fragments are woven with a linen warp and a cotton weft. And finally, also in the Christian cemetery, we found a large coat woven with cotton warp and different woollen weft (probably sheep and camel).

Another use for cotton is in making cord. Up to several dozen metres of cord can be found rolled around some mummies, replacing the traditional bandages (or their narrow newer version). Some of the cotton cord is coated. Analyses have confirmed this and indicated the presence of linseed oil and animal fat. We have not found any published example of comparable treatment on cotton cord from other sites.

16. Heurtel 2003–2004, p. 61. Among other references, G. Castel, who studied a "mummy" of a monk from the Theban necropolis, records a linen binding some 60 m in length by 2.5 cm wide (Castel 1979, p. 122).
17. Gradel *et al.* 2012.
18. Wild *et al.* 2008.
19. Livingstone 2009.
20. Yvanez 2016.
21. Bagnall 2008.
22. Jones 2018.
23. Wild *et al.* 2008, p. 144.
24. Seiler-Baldinger 1994, p. 111; Livingstone 2009, p. 79.
25. Letellier-Willemin & Médard 2012.

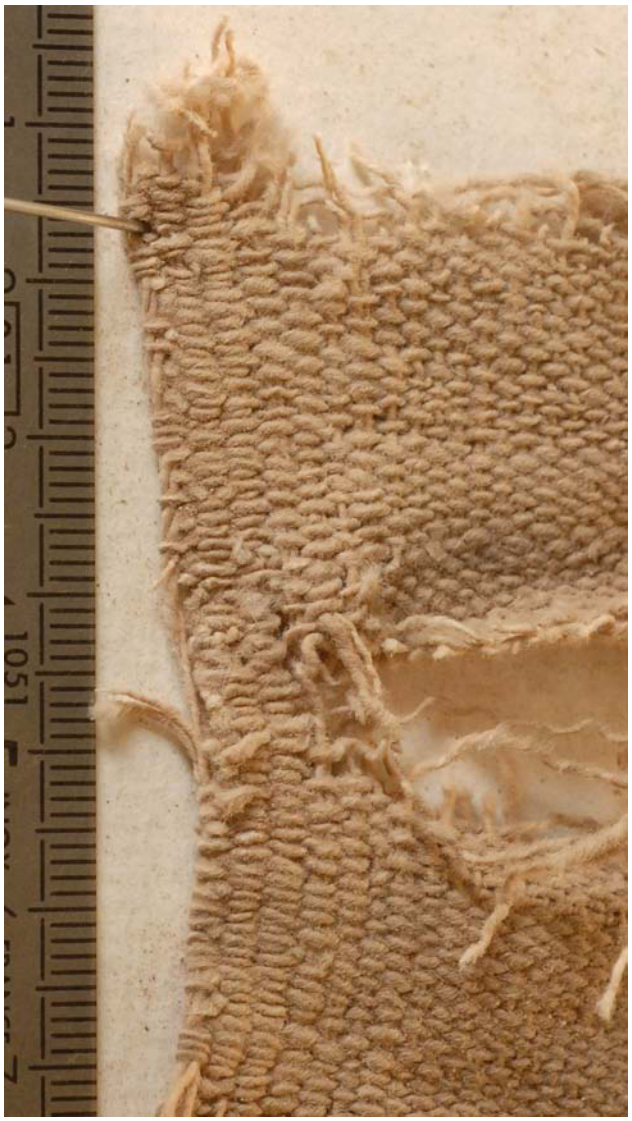

Figure 6. Fragment of a border: cotton fabric (Photo: Fleur Letellier-Willemin © Mission archéologique d'El-Deir/ANR OASIS).

Figure 7. Fragment with piles: cotton fabric (Photo: Fleur Letellier-Willemin © Mission archéologique d'El-Deir/ANR OASIS).

Wool

The woollen textiles come from the Christian cemetery, the workshop of the embalmers, the temple and the fortress. In El-Deir, we found sheep wool with different undyed colours (from white to brown), goat wool, and perhaps camel wool as well. All the threads are S threads except for one, a fine basket weave, with Z threads dyed in a purple-like colour, which suggests a foreign origin.

Working with wool is generally well mastered. There is an example of a fragment with a density of 32 weft yarns per centimetre and 24 warp yarns per centimetre.

Wool is used for the weaving of clothes and accessories. There are two kinds of woollen tunic: made of two parts (Roman type) and woven-to-shape (widespread from the 3rd century AD onwards). We found a woven-to-shape tunic: it is a long undyed tunic with long narrow sleeves. This tunic has been extensively repaired, which involved meticulous needlework that imitated the weaving and respected the appearance of plain weave. The width of the tunic implies the use of a large loom. This tunic has embroidery decoration on the shoulders (fig. 8).

Embroidery is not rare in Kharga, as shown by textiles from the Christian cemetery in Bagawat, near Hibis,[26] and

26. Kajitani 2006.

Figure 8. Fragment of a woollen tunic with embroidered motifs on the shoulders (Photo: Fleur Letellier-Willemin © Mission archéologique d'El-Deir/ANR OASIS).

a tunic from Dush with its embroidery instead of classical tapestry.[27] Tapestry and embroidery are of course very different techniques but it is not just a question of technique. When both are possible, what criteria determine the choice between one over the other?

At the same time, tapestry decoration in wool is also attested in the material from the Christian cemetery at El-Deir. It can be seen on a fragment of a "medallion".

Some linen shrouds from polytheistic cemeteries show looped weft patterns in different dyed wools (fig. 9). According to Christina Rigg, these "concentric circles used as a fill pattern" are characteristic of Kharga Oasis. Such finds date to the 1st century AD. Moreover, these patterns are also visible on sarcophagi and on cartonnages found in Roman necropoleis in Egypt.[28]

A few woollen fragments of tapestry were found in the Roman necropoleis of El-Deir. These fragments bear wave patterns, frequently seen on painted friezes of sarcophagi, with the classic colours of Egyptian iconography, such as red, blue, yellow and green. Some wool braids are decorated with a linen pattern.

Many fragments of tunics display *clavi*. According to the work of Lise Bender Jørgensen, different types of *clavi* imply the use of different looms.[29] Certain *clavi* display crossed warp threads suggesting the use of a vertical loom in their weaving, whereas other *clavi* have a warp that

27. Letellier-Willemin 2013.
28. *Ibid.*
29. Bender-Jorgensen 2011.

is not crossed, suggesting the possible use of a weighted loom. Headscarves are woven with hard twisted threads, making a crêpe look. Comparable scarves were found on a Jewish site near the Dead Sea.[30]

The last example of woollen textiles from a funerary context is a *kentrôn*, wrapping a newborn baby, found in the Christian cemetery. Other *kentrônes* are described from Didymoi in the Eastern Desert and from Masada,[31] while a text from Dakhleh also cites one as a gift.

The fortress has not been excavated until now, but there have been three trial soundings. Some fragments of textiles have been found and they are very important: one is a fragment of *taqueté* work (fig. 10) and one is of a linen textile dyed red and green.[32] They reflect new techniques in weaving and dying. Indeed, the Roman military came from a rather different textile universe.[33] Dated from the 3rd century AD and built under Diocletian, the fortress was probably also a customs post between the oasis, its routes and the Nile Valley.[34]

Final Remarks

The question to be asked after this review of the material from El-Deir is whether the continuity and changes seen within the field of textiles finds an equivalent in the domains of religion, culture and economy. We can confirm a respect for Pharaonic textile traditions during the Ptolemaic period and very largely in the Roman era. The sobriety of the textiles, the plain linen cloth, the few coloured textiles (whose functions are to be determined moreover), the infrequent and repetitive decoration, are not signs of poverty but of respect for aesthetic criteria and an attachment to long-defined values. Among the categories of textiles from El-Deir, there is one that predominates over 800 years and is defined by constant features throughout that long period. This is a plain linen cloth, roughly 100 cm by 200 cm in size that is found on the site and in the cemeteries of all the eras. In consequence, we have opted to use it as a reference textile. It displays an average warp density of 24 to 28 threads per centimetre and weft density of 10 to 12 per centimetre. The threads have a diameter of between 0.3 to 0.4 mm. It requires about 7 to 8 km of thread for its manufacture. Certain textiles of the site, woven with 60 warp yarns and 20 weft yarns per centimetre, need about 16 km of thread. In this way, we can calculate the thread

30. Granger-Taylor 2006, p. 121.
31. Cardon 2003b, p. 635.
32. *Loc. cit.*
33. Mannering 1999.
34. Mattingly *et al.* 2007, p. 154.

Figure 9. Woollen looped weft pattern on a linen shroud (Photo: Fleur Letellier-Willemin © Mission archéologique d'El-Deir/ANR OASIS).

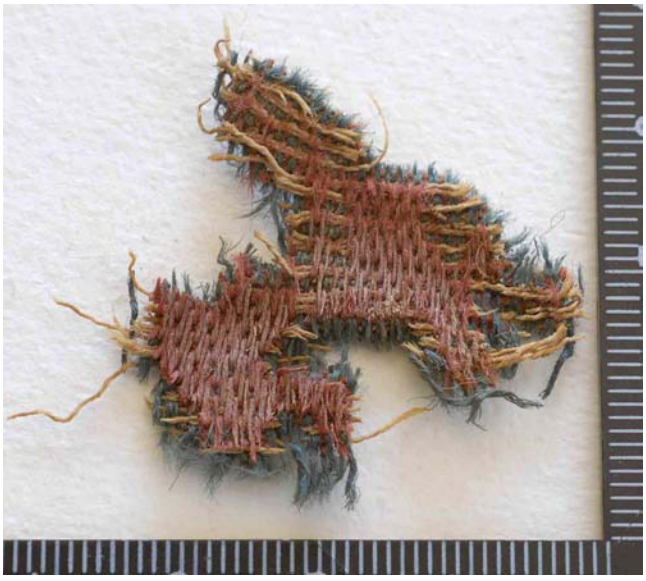

Figure 10. Fragment of a taqueté fabric: wool (Photo: Fleur Letellier-Willemin © Mission archéologique d'El-Deir/ANR OASIS).

necessary for all the cloth present. This sheds a different light upon the material under study and can reveal some basic economic values. The many shrouds discovered in all of the cemeteries of El-Deir raise the possible existence from the 5th century BC until perhaps the 5th century AD of local workshops specialised in their production.[35]

As far as quality is concerned, the presence of some rare but significant textiles are the markers of particular status that is still to be defined, as in the case of a wide binding with two selvedges, a cotton fabric of great quality that is currently unique, and certain cloths of high density used as a support for cartonnage (these re-used everyday textiles inform us of the everyday textile quality).

The textiles of El-Deir allow us to compare the evolution of the three fibres against one another. We must emphasise the predominance of linen, which is the standard fibre until the 3rd century AD. Nonetheless, other fibres appear: cotton towards the end of the 1st century BC–beginning of the 1st century AD, and wool, which is visible above all in textiles from a Christian cemetery (4rd century AD and later). We find cotton in everyday textiles, such as tunics, which are then re-used as shrouds. A surprising observation is that cotton cord in the 4th century replaces the traditional bindings without selvedge and the narrow bindings with double selvedge that are characteristic of this period. These cords represent a very large quantity of cotton thread and thus of fibre.

As regards wool fibre from El-Deir, at the beginning of the Roman period some woollen wefts appeared in linen shrouds and then small medallions. The use of this raw material gradually developed in the Roman era: some deceased were wrapped in linen shrouds and woollen clothes at the same time. In the Byzantine period woollen textiles, notably clothing, become predominant.[36]

The observation of all these changes calls up certain questions. In a place like Kharga, what were the conditions needed for innovations to appear and how much time did it take? Where and how did textile innovations appear? For which persons, of what status, and what identity? When did wool and cotton dominate the textile world of El-Deir?

The variety of weaving techniques attested on the site of El-Deir would seem to prove that, at different times, different looms were used:[37] ground loom, vertical two-beam loom, warp-weighted loom, and tablet loom. It is not always easy to link a type of weaving or decoration to a technique and a tool. Several ways are sometimes imaginable.

Based on archaeological findings, including the textiles, the most prosperous time for the site of El-Deir was during the Ptolemaic period. Research into the textiles of El-Deir contributes to the study of a territory, of agriculture, of livestock and the management of water, for example. Each fibre, made of flax, cotton or wool, is a marker of the interaction between the economy of the region and a common citizen and of the interaction between tradition and change.[38]

The tools used with each fibre, the existence of workshops, specialised or not, and importations are all important questions to be considered, the same questions that we find in the study of ceramics.[39] The three fibres and the associated weaving techniques reflect the identity of the inhabitants of El-Deir and studying these textiles is like mapping the area and its many routes and crossroads over time.

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35. Other specialised local workshops are known from the Nile Valley, *e.g.* Qarara (Sharuna), Middle Egypt: end of 4th–8th century AD (Huber 2015).

36. Letellier-Willemin 2012.

37. Wild 2015.

38. About the economy of textiles and textile production within the oasis context see also the article by Jennifer Cromwell, in this volume (Cromwell 2020).

39. Ballet 1998.

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Textiles from a Late Roman/Byzantine ecclesiastical centre at Abu Sha'ar, Egypt

Lise Bender Jørgensen

Around AD 400 a group of Christians were looking for a new home. An abandoned Roman military fort at what is now called Abu Sha'ar, *c.* 20 km north of Hurghada on the Egyptian Red Sea coast, became the answer to their prayers.[1] Steven Sidebotham of the University of Delaware excavated the site in 1987-1993.[2] The fort had been established in AD 309-311 to house a mounted unit, the *Ala Nova Maximiana*, guarding the *Via Nova Hadriana*. The military phase was however short-lived: the soldiers abandoned the fort before AD 400. The new settlers turned the former military headquarters into a church, complete with a martyr's tomb, and left various inscriptions, *graffiti* and Christian crosses on the walls.[3] According to Sidebotham's early excavation reports the Christians were monks or hermits.[4] Later, he describes this later phase of Abu Sha'ar as an "ecclesiastical center".[5] This is due to the find of an almost complete papyrus in the church that papyrologists Roger Bagnall and Jennifer Sheridan date to the 5th century AD: a letter from Apollonius to Father John and his daughter Sarah, deploring the capture of his city but rejoicing in the saving of Father John and all of his dependants.[6] That the dependants of Father John included at least one woman suggests that Abu Sha'ar was a settlement of Christians rather than a monastery or, perhaps, a place of pilgrimage to the now forgotten martyr's tomb. A *graffito* saying "I, Andreas, traveller to India, came here…" may have been left by a pilgrim.[7] It is unknown when the Christian settlement ended; supposedly this happened peacefully in the 7th century or later, perhaps associated either with the Sassanian invasion in AD 619-629 or the Muslim conquest in AD 640/641.[8]

The items found during Sidebotham's excavations at Abu Sha'ar included more than 1100 textile fragments that were examined by myself (1990-1991) and A. Marion I. van Waveren (1993).[9] Most of them are from the military phase, but a significant number belong to the Christian settlement. The latter came from Trenches N (kitchen), R *horrea* (stores), R/N (kitchen/stores), the upper layers of D, O and V (*principia*/church), T (mill/oil press), Y (street/stores), W (north gate) and Z (store) (fig. 1). In previous presentations and publications my main focus has been on the early group; now it is time to take a closer look at the textiles of the Christian settlement.

Published in Maria Mossakowska-Gaubert, ed., *Egyptian Textiles and Their Production: 'Word' and 'Object' (Hellenistic, Roman and Byzantine Periods)* (Lincoln, NE: Zea Books, 2020). doi 10.32873/unl.dc.zea.1082

1. 29°22.125' N/33°40.970' E.
2. Sidebotham 1989, 1991, 1992, 1993, 1994a, b.
3. Sidebotham 1993, 1994a; Bagnall & Sheridan 1994a, b.
4. Sidebotham 1992, p. 34; Sidebotham 1994a, p. 156.
5. Sidebotham 1993, p. 7; Sidebotham *et al*. 2008, p. 59–60 and 145–147.
6. Bagnall & Sheridan 1994a, p. 164–166.
7. Bagnall & Sheridan 1994b, p. 112.
8. Sidebotham 1994a, p. 156; Sidebotham *et al.* 2008, p. 60.
9. Bender Jørgensen 2004, 2006, 2007, 2018a, b. I examined the textiles numbered AS 1–757, van Waveren AS 758–1102.

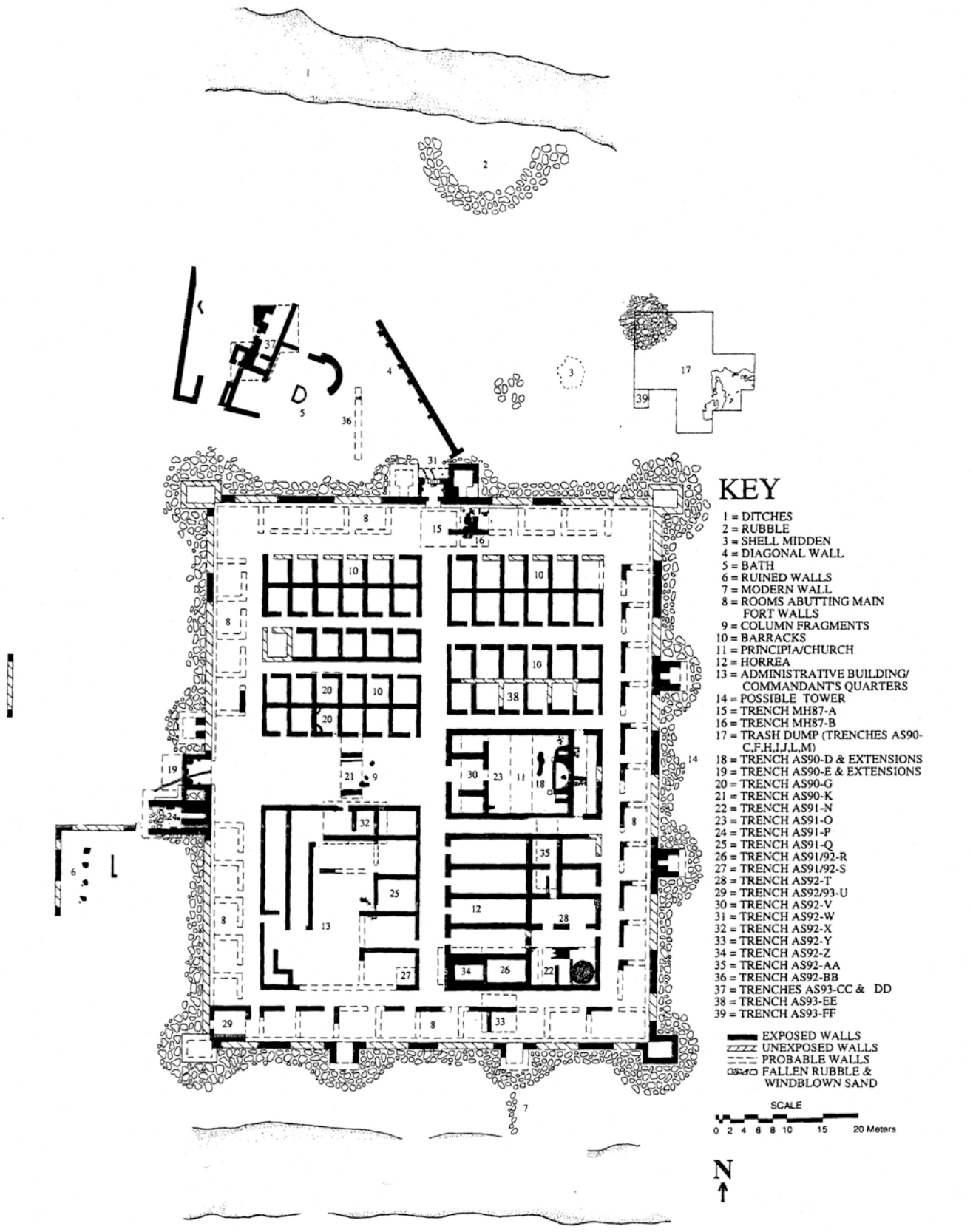

Figure 1. Plan of the fort at Abu Sha'ar with list of trenches. (Drawing © reproduced with permission from Steven E. Sidebotham).

Dating and phasing Abu Sha'ar

The founding of Abu Sha'ar as a military fort in AD 309-311 is documented by an inscription found at the west gate; coins and some ostraca also belong to the military phase (AS I). A Greek inscription asking the Lord Jesus Christ to save and have mercy on his servant Salamanis and the papyrus addressed to Father John are dated by their style of writing to the Christian phase (AS II).[10] This also applies to a *graffito* of a large cross, accompanied by a prayer beseeching the god of Abraham, Isaac and Jacob, the holy god-bearer Mary, the Holy Trinity and the Lord Jesus Christ to have mercy on their worthless servant,[11] and a few other texts. Except for these sources the dating and phasing of Abu Sha'ar depend on the pottery that was examined by John Riley. His report forms the basis of the phasing of the textile finds[12]. As regards the *principia*/church, this however poses some problems. Trench D (the apse area) including extensions D NEX, D SEX, D WEX produced little pottery, most of it scrappy, nonetheless Riley was able to establish two phases. The presence of Later Roman Bii amphora showed that the upper layers of these trenches belong to the Christian phase (AS II), but Riley does not supply a list of these upper layers, and textiles from Trenches D, D NEX, D SEX and D WEX therefore remain largely un-phased. Riley's catalogue does however make it possible to add textiles from D 003 and D.S. balk to Phase II. A textile wrapped around the bones of the supposed martyr (D WEX 016) certainly belongs to the Christian phase.[13] In addition, several large textile fragments, including a small tapestry found in D WEX layer 002, are also likely to belong to the Christian phase.[14] According to Riley, all pottery from Trench O belongs to the military phase (AS I); the same applies to Trench V except for V 011 and V 022. Again, some exceptions can be identified. The almost complete papyrus datable to the 5th century AD comes from Trench O, layer 022.[15] A tapestry showing a cross, found in Trench O, layer 023 must also belong to the Christian phase.[16] This adds eight textiles to the 272 listed as AS Phase II in previous works.[17]

Fibres

Lack of laboratory facilities made it impossible to carry out formal fibre identification of the Abu Sha'ar textiles.[18] Accordingly, fibres are classified according to the investigators' experience. The site's proximity to the Red Sea meant that all textiles were thoroughly impregnated with saline substances. This made them soapy to the touch and it was particularly difficult to identify the fibres. Attempts to remedy this by washing the textiles merely resulted in making them stiff and hard. The results must therefore be taken with a pinch of salt. Nonetheless *c.* 27% of the now 280 fragments have been categorised as wool, 54% as flax, hemp or other bast fibre, 2% as goat hair and 7% as cotton. A few combine flax and wool, or wool and cotton. Compared with textiles from the earlier phase and with sites from the Eastern Desert of the 1st and 2nd centuries AD where wool was predominant,[19] wool and bast fibres have changed places.

Yarns

A large majority of fabrics were made entirely from s-twisted yarns. This applies to almost all of those made of flax or other bast fibres: only five are made of z-twisted yarns. The wool textiles show more variation: 58 are made of s-twisted yarns in both systems, three are z-z or z-zz, seven s-z or z-s and one Z2s-s. Two goat hair fabrics are s-s, one z-z, and all cottons but two are s-s or ss-ss. Compared with the military Phase 1, and with Mons Claudianus,[20] we see a gradual increase of s-s twisted yarns while the use of z-twisted yarns dwindles.

10. Bagnall & Sheridan 1994a, p. 159–163; Sidebotham 1994a, p. 136.
11. Bagnall & Sheridan 1994b, p. 114.
12. Riley 1994.
13. AS 755.
14. AS 400. Depicted in fig. 31 in Bender Jørgensen 2018a and b.
15. AS91–15–3; Bagnall & Sheridan 1994a, p. 164–166; Sidebotham 1994a, p. 141.
16. AS 649. Depicted in Sidebotham *et al.* 2008, pl. 6.11, and in fig. 29 in Bender Jørgensen 2018a, b.
17. Bender Jørgensen 2007, table 1; Bender Jørgensen 2018a, b, table 8.
18. Work conditions were much like those described in Bender Jørgensen & Mannering 2001.
19. Bender Jørgensen 2004, p. 91–92; Bender Jørgensen 2006a, p. 166; Bender Jørgensen 2007, p. 28–29; Bender Jørgensen 2018a, b, fig. 43.
20. Bender Jørgensen 2018a, b, tables 4–6 (MC) compared to tables 9–11 (AS I).

Weaves

The weaves are mostly tabby and derivate of tabby, such as half-basket and basket weave. This applies to all fibre types. Five pieces, all of them wool, were twill. Three are densely woven 2/2 diamond twills: two are plain diagonal twills.[21] One piece proved to be *taqueté façonné*; it is also of wool.[22] Five fragments with tapestries are all wool on flax.[23] Two pieces are categorised as felt:[24] one is wool and the other probably also wool. Compared with the military phase and other sites in the Eastern Desert we see that the number of twills has decreased. I have previously argued that twills derive from military garb.[25] The presence of five twills from the Christian settlement apparently contradicts this, although as one comes from the sweep and three from top layers, they may in fact be scraps from the military phase that have been re-deposited. They may, however, also represent civilian clothing. Hero Granger-Taylor has convincingly argued that civilians as well as the military used twill cloaks for outdoor activities in the Roman world.[26] Similar cloaks have continued to be in use. Several are known from the Byzantine period[27] and the Berbers of North Africa still use them.[28]

Borders and selvedges

Edges appear in the form of four transverse borders.[29] One (fig. 2) appears to be a starting border of the type associated with the warp-weighted loom.[30] Three are twined or cordeline (fig. 3), and may be starting borders of the type associated with the two-beam loom,[31] or corded/plaited closing borders.[32] Twenty-eight simple selvedges are in bast/flax fibres, and one in cotton. Four reinforced selvedges are in wool, four in bast/flax. Those in wool are made over two or three groups of threads.[33] They are often

Figure 2. AS 826-827. Starting border of the type associated with the warp-weighted loom. Identified as plant fibres, probably flax. Surface find from Trench Y. (Photo © A. Marion I. van Waveren).

Figure 3. AS 970. Twined starting border found in Trench Z, layer 006. (Photo © A. Marion I. van Waveren).

21. Diamond twills AS 634, 667, 730: plain twills AS 352, 961.
22. AS 642. Depicted in fig. 28 in Bender Jørgensen 2018a, b.
23. AS 400, 649, 650, 699, 889. AS 400 is depicted in fig. 31, AS 649 in fig. 29 and AS 699 in fig. 33 in Bender Jørgensen 2018a, b.
24. AS 713, 861.
25. Bender Jørgensen 2004, p. 94–97; Bender Jørgensen 2006a, p. 167–171; Bender Jørgensen 2007, p. 28–29; Bender Jørgensen 2018a, chap. 47; Bender Jørgensen 2018b, chap. 46.
26. GrangerTaylor 2008, p. 12–13; see also Cardon *et al.* 2011, p. 319–320.
27. Granger-Taylor 2007.
28. Rabaté & Sorber 2007, p. 55–58 and 134.
29. AS 763, 826–827, 868 and 970.
30. AS 826–27. Ciszuk & Hammarlund 2008, p. 122–124.
31. AS 763, 868 and 970. Unfortunately, no photos exist of AS 763 and AS 868. Cf. Granger-Taylor 1982, figs. 14–15; Sheffer & Granger-Taylor 1994, fig. 53; Ciszuk & Hammarlund 2008, p. 124–127; for variations of these, see also Verhecken-Lammens 1993, figs. 2–11.
32. Granger-Taylor 1982, figs. 18–19; Sheffer & Granger-Taylor 1994, figs. 13, 57; Cardon *et al.* 2011, fig. 304.
33. See Bender Jørgensen 2007, p. 33–34 for definitions of selvedge types.

Figure 4. AS 888. Fragments of reinforced selvedge from tunic with red bands. The selvedge is torn off to be re-used as string. Surface find from Trench R at S balk. (Photo © A. Marion I. van Waveren).

Figure 5. AS 824. Composite check. Found in Trench R, layer 048. (Photo © A. Marion I. van Waveren).

torn off the cloth and re-used as string (fig. 4). Those of bast/flax are made with one group of threads, except one where the two outermost threads are paired.[34] Compared to the military phase and to Mons Claudianus, simple selvedges are becoming more common while reinforced selvedges are getting rarer.[35]

Decoration

Several types of decoration were found. They consist of woven decoration such as bands, checks, self-bands and rows of twining,[36] and applied decoration, such as pile. Ten textile fragments had bands; they are mainly bar bands.[37] One is a pin band[38] and one a composite band.[39] In some cases these bands are only discernible in the torn off selvedge (fig. 4). None of the rather narrow bar bands resemble the *clavi* commonly found in the early sites of the Eastern Desert.[40] Five pieces are checked: two grid checks,[41] one block check[42] and two composite checks.[43] The raw material of the checked fabrics is difficult to determine but it is likely to be of wool or cotton. One of the two composite checks is described by van Waveren as flax, the other as flax or cotton, but their patterns have close parallels in wool fabrics from Mons Claudianus[44] and in a cotton from Berenike.[45] The Abu Sha'ar composite checks are therefore likely to be cotton or wool rather than flax (fig. 5). The grid checked pieces are similarly described as flax but more likely to be cotton.[46] Both are made from s-twisted yarns; the cottons from contemporary layers at Berenike are made from z-twisted yarns and supposedly come from India.[47]

34. AS 670.
35. Bender Jørgensen 2007, p. 29; Bender Jørgensen 2018a, b, figs. 41–42.
36. For definitions, see Bender Jørgensen 2007, 2008 and 2011.
37. AS 625, 644, 672, 741, 754, 888, 931, 1040. For definitions of band types, see Bender Jørgensen 2011, p. 78.
38. As 871.
39. AS 733.
40. Bender Jørgensen 2007, p. 29; Bender Jørgensen 2011, p. 77–78.
41. AS 960, 975. For definitions of check types, see Bender Jørgensen 2011, p. 77–78.
42. AS 898.
43. AS 824, 829.
44. For example, MC 768, see Bender Jørgensen 2007, p. 32, fig. 11.
45. Wild & Wild 2018, fig. 48.
46. AS 960 and 975. Compare AS 960 depicted in fig. 9 in Bender Jørgensen 2007 with Wild & Wild 2018, fig. 49.
47. Wild & Wild 2018, chap. 24.

Figure 6. AS 988. Weft-faced wool tabby with two rows of twining. Found in Trench T SBEX, layer 004. (Photo © A. Marion I. van Waveren).

Twining was found in five pieces, all made of wool.[48] They are likely to represent the remains of tunics or cloaks, where twining was used to reinforce areas exposed to particular strain.[49] Two of them have several rows of twining, separated by a few centimetres (fig. 6). No less than sixteen pieces are decorated with self-bands,[50] one with self-checks.[51] This stands for paired or triple threads in warp or/and weft creating subtle patterns (fig. 7). They fall in several categories but most may be characterised as SGT, Stripes through Groups of Threads.[52] All of them are of flax or cotton. One of them comes from the presumed martyr's burial. This is a relatively large piece, 26 x 22 cm, woven in tabby with groups of triple threads in one system. The fibre is plant fibre, presumably flax; the yarns were s-twisted in both systems, and the fabric had 11/12 threads per centimetre.[53]

Figure 7. AS 830. Cotton or linen tabby with two rows of connected self-bands. Found in Trench R, S balk trim. (Photo © A. Marion I. van Waveren).

Five pieces are designated as tapestry.[54] All are plain linen tabbies decorated with figured tapestry in coloured wool. The linen ground weave is made of s-twisted yarns in both systems, except in one piece[55] that has Z2s-plied warp. One is a small loose piece in green and black; the green yarn is z-twisted, the black s-twisted. It was found with large fragments of linen textile decorated with weft-float bands.[56] The second, found in the church, displays a black, gem-incrusted cross, the gems in red, green and white. The black, red and green pattern wefts are z-twisted wool, while s-twisted linen yarn was used for the white ones.[57] The third tapestry is a very small fragment that cannot be further described,[58] while the fourth[59] is obviously the decorated neckline of an under-tunic like those seen in a number of mummy portraits.[60] The motif of the fifth tapestry (fig. 8) is less easy to identify.[61] It may come from a tunic, or perhaps a wall hanging. The wool yarn of these last three tapestries is s-twisted.[62]

48. AS 578, 608, 613, 614, 988.
49. Granger-Taylor 1982, p. 16–18; Verhecken-Lammens 1994, p. 84–92.
50. AS 755, 772, 784, 785, 786, 812, 828, 830, 833, 841, 862, 872, 915, 923, 943, 1102.
51. AS 951.
52. For definitions of types of self-bands, see Bender Jørgensen 2008.
53. AS 755, found in Trench D WEX, layer 016. Unfortunately, no photo of this textile exists.
54. AS 400, 649, 650, 699, 889.
55. AS 650.
56. AS 400, depicted in fig. 31 in Bender Jørgensen 2018a, b.
57. AS 649, depicted in pl. 6.11 in Sidebotham *et al.* 2008, and fig. 29 in Bender Jørgensen 2018a, b.
58. As 650.
59. AS 699, depicted in fig. 33 in Bender Jørgensen 2018a, b.
60. Walker & Bierbrier 1997, p. 99 and 106–107.
61. AS 889.
62. AS 650, 699, 889.

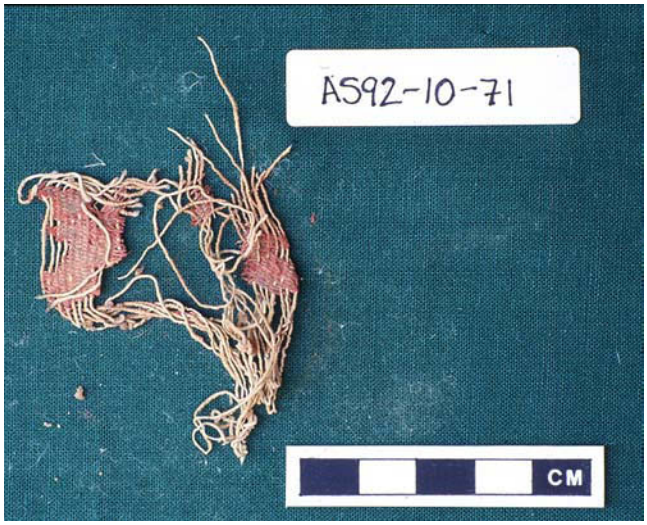

Figure 8. AS 889. Remains of figured tapestry, red wool on linen warp. Found in Trench Z, layer 002. (Photo © A. Marion I. van Waveren).

Figure 9. AS 870. Linen textile with blue-green pile. Found in Trench T WEX, layer 004. (Photo © A. Marion I. van Waveren).

A fragment of a *taqueté façonné* was found in the *horrea*/stores.[63] It is of wool, 20 x 13 cm, made of s-twisted yarns, and the pattern has the remains of a repp border (warp: natural colour; weft: repp border blue/green, pattern: natural colour and red). Wool *taquetés* are well known from early Roman sites in Israel and Egypt's Eastern Desert,[64] and are also found in Late Roman/Byzantine deposits at Berenike.[65] The Berenike *taquetés* are worn on one side and are presumed to represent the remains of soft furnishings, such as cushion or mattress covers. This is also likely to be the case of the Abu Sha'ar *taqueté*. As shown by Martin Ciszuk, *taqueté façonné* can be woven on a Roman two-beam loom, entered like the *zilu* loom and equipped with a pattern harness.[66] This, and the fact that the majority of wool *taquetés* have been found in Egypt leads him to argue that they were produced in specialised workshops in the Nile Valley.[67]

Piled fabrics form a small but nonetheless important group among the textiles from Abu Sha'ar Phase II. Four piled fabrics have been recorded.[68] Two are described as flax, one as cotton, one as wool. The one in cotton is in basket weave s-s, with Z2s pile.[69] It ends in a hardened point that made van Waveren suggest that it could come from a loincloth. The one in wool is multi-coloured, woven in a form of tabby from S2z-plied yarns.[70] One of the linens has blue-green pile in Z2s-plied yarn that is likely to be wool;[71] the pile is inserted in pairs, with knots at the end (fig. 9). In another case, the pile is just a 3.8 cm long thread tied and ending in a knot.[72] All come from the *horrea*/stores.

One fragment has an ink mark in the form of a rather lopsided cross in red ink (fig. 10). The textile is a tabby-woven fabric in plant fibre, possibly cotton. Both selvedges are preserved. They show that it was a narrow textile, c. 10 cm wide. This suggests that it is the remains of a sash or scarf, or perhaps leg wrappings. Another fragment appears to come from the same item.[73]

63. AS 642, depicted in fig. 28 in Bender Jørgensen 2018a, b.
64. Sheffer & Granger-Taylor 1994, p. 212–215; Ciszuk 2000, 2004; Cardon 2003, p. 635.
65. Wild & Wild 2018, chap. 20, figs. 41–42.
66. Ciszuk 2000, 2004.
67. Ciszuk 2004, p. 112–113.
68. AS 870, 880, 932, 949.
69. AS 880.
70. AS 949.
71. AS 870.
72. AS 932.
73. AS 734.

Figure 10. AS 735. Linen or cotton textile with red ink mark. Both selvedges preserved, showing it was of narrow width, c. 10 cm. Found in Trench N, layer 020. (Photo © Lise Bender Jørgensen).

Life and textiles at Abu Sha'ar

Who were the people who settled in the abandoned Roman fort next to the Red Sea? The papyrus found in the church from Apollonius to Father John mentions Father John's wife, Slamo, who sends greetings to her husband and daughter.[74] Slamo is a Semitic name and suggests that the family's origin was in the Sinai or Arabia. Neither the papyrologists nor the excavator is however putting any weight on this possibility.[75] Instead, Sidebotham tends to suggest that they were fugitives from the Nile Valley.[76] Salamanis, who beseeched Jesus Christ to have mercy on him, is likely to have come from Syria or Palestine,[77] and Andreas, who passed by on his way to India,[78] are further evidence of a transient population of mixed ethnicity.

What do the textile remains tell us about these people and of their life? The 280 fragments comprise quite a wide range. They include fine, medium and coarse fabrics. Some are obviously from clothing, like the tapestry neck edging of an under-tunic.[79] The reinforced selvedges of wool

74. Bagnall & Sheridan 1994a, p. 164–166.
75. Bagnall & Sheridan 1994a, p. 164–165; Sidebotham *et al.* 2008, p. 145.
76. Sidebotham *et al.* 2008, p. 59.
77. Bagnall & Sheridan 1994a, p. 164.
78. Bagnall & Sheridan 1994b, p. 112.
79. AS 699, depicted in fig. 33 in Bender Jørgensen 2018a, b.

fabrics turned into strings for tying things up, such as the one depicted in fig. 4, are made from very fine yarns and stem from good quality tunics. The linen textile with weft-float bands and a small tapestry is also likely to be from a tunic.[80] This may also be the case of the tapestry shown in fig. 8. The cotton with self-bands (fig. 7) may come from another tunic; the same applies to the textile wrapped around the martyr's bones. The wool fabrics with twining, such as fig. 6, may come from sleeved tunics or hooded cloaks and, as mentioned above, all the twills are presumably from cloaks.

The tapestry cross is likely to come from an altar decoration or perhaps a clerical vestment.[81] Other fragments are likely to be from soft furnishings. *Taquetés* are, as mentioned above, usually cushion or mattress covers. A brown wool fabric with cotton stripes[82] could be the remains of a coverlet, the multi-coloured piled wool fabric the remains of a rug,[83] and the linen with blue-green wool pile (fig. 9) might represent a wall hanging. The fabrics with composite checks like fig. 5 have parallels among the mattresses depicted in Pompeii's brothels,[84] and the worn surface of one of them suggests that the Abu Sha'ar pieces may also have been mattress covers.

Compared to the earlier, military phase of Abu Sha'ar and to other, even earlier sites in the Eastern Desert, we see a series of changes. As regards fibres, wool appears to have become less important; the use of s-twisted yarns increases. Twill is relatively frequent from the military phase and at the early Roman sites in the Eastern Desert, but does not appear much used in the Christian settlement. This, in sum, suggests that the range of textiles available to the Christian settlers was limited compared to what was available to the soldiers. They were however not without luxuries, as shown by the tapestries, the *taqueté*, the colourful piled rug and the possible wall hanging. Many textiles may have been hand-me-downs acquired from second-hand dealers, the *centenarii*,[85] but other items, like the tapestry cross, must have been made for the purpose.

Did the Christians at Abu Sha'ar produce their own textiles? They were able to draw on two wells constructed by their army predecessors.[86] The closest, 1 km away, had a pipeline leading directly to the fort. It worked under pressure, supplying up to 74 litres per minute. A second well was located 6 km away. This made it possible to irrigate surrounding land and grow grain and vegetables. According to Sidebotham, both water installations were in use during the Christian occupation. The wells mean that it might have been possible to cultivate flax and perhaps cotton. Sheep could have been be grazed in the neighbourhood. An amphora shoulder shard found in the baths outside the fort had an ink inscription in Greek: three words in three lines written in a hand datable to the 5th-6th centuries. According to Bagnall and Sheridan, the middle word κροκυ may refer to wool, or to the nap of woollen cloth. They consider it an odd word to find on an amphora but add that these jars were used for a wide variety of products.[87]

No textile tools were found during the excavations. The lack of spindle whorls is particularly conspicuous, although, as Grace M. Crowfoot's work on hand-spinning methods shows, whorl-less spindles can be used to make fine yarns.[88] As regards looms, neither the ground loom nor the two-beam loom would have left many traces. Both are still used in Egypt and other parts of North Africa[89] and some of the transverse borders found at Abu Sha'ar (fig. 3) are consistent with these loom types.[90] The warp-weighted loom may have served to produce the single item with starting borders (fig. 2), but the absence of loom weights indicates that this did not happen at Abu Sha'ar.

We may perhaps conclude that it is possible that women among the Christians, such as Father John's daughter Sarah, did produce a limited amount of textiles but it is unlikely that they could manage to make enough for everybody's needs.

80. AS 400, depicted in fig. 31 in Bender Jørgensen 2018a, b.
81. AS 649, depicted in pl. 6.11 in Sidebotham *et al*. 2008, and fig. 29 in Bender Jørgensen 2018a, b.
82. AS 673.
83. AS 949.
84. Bender Jørgensen 2011, p. 77.
85. Forbes 1964, p. 238–239; Mannering 2006, 153, Cardon *et al.* 2011, p. 276.
86. Sidebotham 1994, p. 263–268; Sidebotham *et al.* 2008, p. 317.
87. Bagnall & Sheridan 1994b, p. 110–111.
88. Crowfoot 1931, p. 10–11, pl. 4–5.
89. Reswick 1985, p. 49–83; Picton & Mack 1989, p. 55–67; Spring & Hudson 1995, p. 33–38; Maurieres *et al.* 1996, p. 111–112.
90. Ciszuk & Hammarlund 2008, p. 120–127.

Acknowledgements
Thanks are due to Professor Steven Sidebotham, University of Delaware, who invited me to join his excavation team at Abu Sha'ar, to Gillian Vogelsang-Eastwood for her assistance, to Hero Granger-Taylor who has always generously shared her knowledge on Roman textiles and clothing, and to A. Marion I. van Waveren who recorded the textiles from the 1992-1993 seasons and graciously handed all her documentation over to me.

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Reconstruction of a deconstructed tunic

Anne Kwaspen

Introduction

Tunics of the 1st millennium AD can be classified into two main groups according to the direction of the warp in the finished tunic.[1] The first group of tunics has horizontal warp threads in the finished tunic. This means that the cloth as it is worn is rotated 90° from the weave direction on the loom.[2] In the second group of tunics the warp runs vertically in the finished tunic. Each group of tunics has their typical technological features and finishing methods, with additional distinctions between wool and linen tunics.[3] This article focuses on the study of a tunic belonging to the first group with horizontal warp and all technical features that are discussed below are related to this type only.

In addition, tunics can be subdivided depending on whether they have sleeves. Within the group of tunics with horizontal warp, numerous tunics with woven-on sleeves are in museum collections, but sleeveless tunics are unusual. Most of these sleeveless tunics are made of wool and are small children's tunics. Even though they are represented on mosaics and paintings, only a few wool tunics for adults are known from excavation reports or museum collections.[4]

The Louvre Museum has in its collection one colourful sleeveless wool tunic (AF 12249), which, according the dimensions (height = 112 cm and 117 cm with fringes, width = 89/93cm, circumference neck opening = 58 cm, arm opening = +/- 32 cm, distance shoulder line-waist tuck = 56 cm), is clearly for an adult (fig. 1). Although very fragile, this tunic has not yet undergone conservation treatment, so the weave is not yet fixed on a support fabric. It was therefore possible to analyse details of both the inside and outside of the tunic.

Weave and design

The cloth is woven with a red wool warp (S-spun), 9 threads/cm. Red, green, yellow and natural-coloured wool (S-spun), supplemented with natural-coloured linen (S-spun), was used as weft yarn. The number of weft threads, 22/cm, is well above the number of warp threads, as a result of which the weave has a weft-faced tabby structure. However, the warp is not completely covered by the weft, which gives a mottled effect in the yellow and green stripes. After finishing the weave the warp was worked into two different finishing borders, with a twisted border on one side and a braided border on the other.[5]

The design of the weave is formed by small and wider stripes running from hem to hem. A small plain green stripe at the outermost edge is followed by a plain yellow stripe. Next comes a wide green stripe, followed by a

Published in Maria Mossakowska-Gaubert, ed., *Egyptian Textiles and Their Production: 'Word' and 'Object' (Hellenistic, Roman and Byzantine Periods)* (Lincoln, NE: Zea Books, 2020). doi 10.32873/unl.dc.zea.1083

1. Description of the different types of tunics: Kwaspen & Verhecken-Lammens 2015.
2. Detailed description of the construction of tunics: Verhecken-Lammens 1993, p. 41–52; Verhecken-Lammens 1994.
3. See Kwaspen & Verhecken-Lammens 2015.
4. Catalogue of sleeveless tunics in museum collections and published archaeological sites: Morgan 2018, p. 149–150.
5. Description and drawings of different finishing borders: Verhecken-Lammens 1997, p. 94–95.

Figure 1. Tunic AF 12249. Musée du Louvre. (Photo: Anne Kwaspen © Musée du Louvre).

Figure 2. a. Fragment E 29306; **b.** Fragment E 29308; **c.** Fragment AF 5989. Musée du Louvre. (Photos: Anne Kwaspen © Musée du Louvre).

patterned stripe in white, yellow and red. Next is a significantly wider red stripe. In the centre of the tunic two similar patterned stripes flank a small plain green stripe. The other side of the weave mirrors the first part described above. The patterned stripes consist of two small yellow stripes on the outsides, with yellow wave motifs on a red background next to it in the middle. The central decoration of the stripe is woven in slit tapestry technique with eccentric wefts, where eye-shaped motifs alternate with fine unidentifiable stylised plant motifs.

Wool tunics patterned with woven-in tapestry bands held in museum collections display a considerable variety of decoration and use of colour. It is therefore rather exceptional to find the same type of patterning on tunics (fragments) in different collections. The Louvre Museum has three other wool fragments, E 29306, E 29308 and AF 5989, with similar design and woven in the same colours (fig. 2). Fragments E 29306 and E 29308 even have the same sequence of stripes as tunic AF 12249. In addition, the Museum für Byzantinische Kunst in Berlin (inv. 11467)[6] and Bolton Museum (inv. 26.1914.34)[7] have a comparable fragment in their collection.

Wool tunic in three parts

All published and more or less complete sleeveless wool tunics are woven in one piece,[8] where a wide warp (full length of the tunic from hem to hem) was placed on the loom, requiring probably two weavers working side by side to weave it.[9] It was therefore surprising to discover that this tunic AF 12249 consists of three parts. Of wool tunics woven-to-shape with sleeves, few examples made in

6. Fluck *et al.* 2000, p. 65–67.

7. Pritchard 2013, p. 38–39.

8. BM 2004,0910.5 in Morgan 2018, p. 100; the Phoebus Foundation KTN 789–02, KTN 789–03 and KTN 741: in De Moor *et al* 2008 p. 162–163 and Kwaspen & Verhecken-Lammens 2015, p. 154; Abegg-Stiftung 4219: in Wild 1994, p. 9–36; V&A 636–1886: in Kwaspen & Verhecken-Lammens 2015, p. 154; Qustul (Nubia), grave Q150 20349: in Mayer Thurman, p. 69.

9. Pritchard 2006, p. 45.

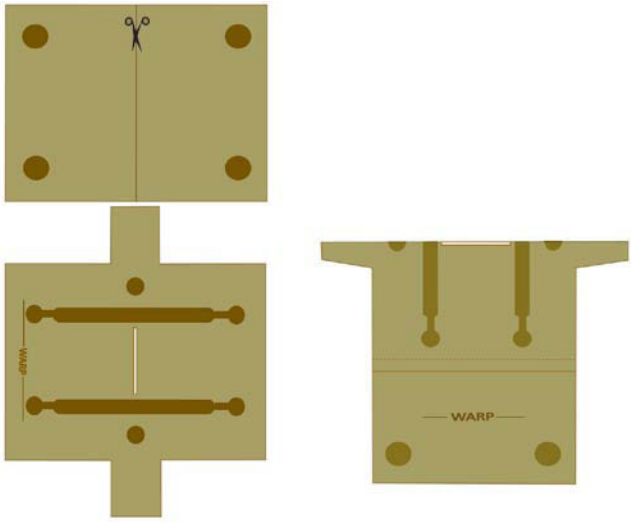

Figure 3. Drawing of a woven-to-shape tunic in three parts. (Drawing © Anne Kwaspen).

three parts are known.[10] Instead of a complete warp, only the warp needed for the upper part was set up on a small loom.[11] The length of the warp is calculated for weaving the width of the woven-to-shape upper part followed by a second part to create the lower parts of the tunic. To construct the tunic, this second part is divided in two equal parts, to form the front and back 'skirt' of the tunic. These parts are sewn to the upper part along the waistline, the seam being hidden inside the waist tuck. The selvedges of the upper part form the seam together with the cut edge of the lower parts (fig. 3).

On investigation of the waist tucks of the front and back of tunic AF 12249, no selvedges were found on the upper part. On both sides the upper part has cut edges instead (fig. 4).

The neck opening

Most sleeveless wool tunics have a woven-in neck slit, constructed on the loom. The selvedges of the neck slits are always reinforced either by grouping warp threads or most often by bringing supplementary warp yarns into the structure. These extra warp yarns are held and divided by weft countered twining on one side, and eliminated by working

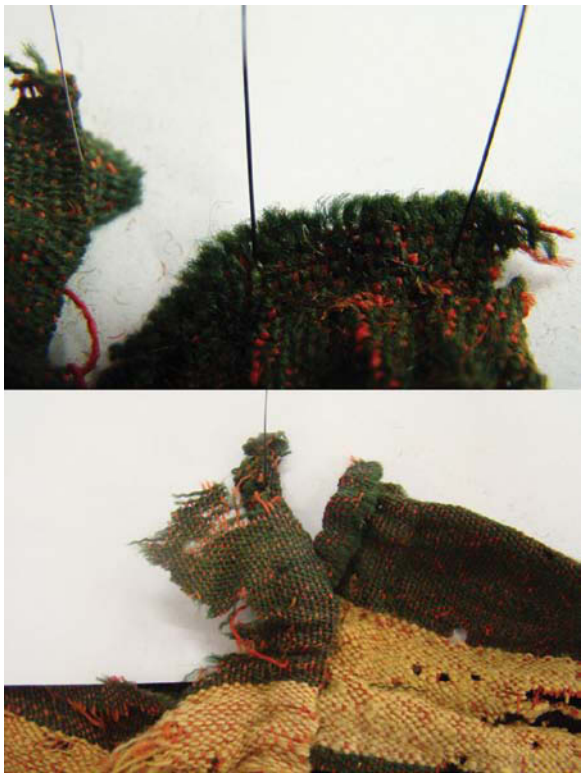

Figure 4. Tunic AF 12249. Detail of waist tuck: cut edges. (Photo: Anne Kwaspen © Musée du Louvre).

these extra threads into countered twining on the other side. The slit corners are also strengthened by weft twining.[12]

Tunic AF 12249 is also an exception with regard to the neck opening, because it is cut. The finishing of this cut-out opening is also unusual. Generally, the edge of the opening would be folded to the outside and then finished with an applied trimming, but in this tunic the edge is turned towards the inside as a rolled seam. No reinforcement by weft twining near the neck opening is detected, which could indicate an alteration of the neck opening after it had been damaged.

Weft twining

3-3 weft twining can be found, however, at two unexpected places in the weave. Several red wool yarns are (counter) twined in weft direction from the hem and tuck upwards only on the front side of the tunic (fig. 5).

10. Examples known and analysed by the author: Victoria & Albert Museum, London, V&A 291–1891: published in Haldane 2009, and Haldane & Persson 2019; Museum of Applied Arts, Vienna, MAK T1, MAK 10758, see online catalogue: https://sammlung.mak.at/sammlung_online?id=collect-260097 (last checked: 28/6/2019) and https://sammlung.mak.at/sammlung_online?id=collect-108210 (last checked: 28/6/2019).
11. Verhecken-Lammens 1993, p. 43–45.
12. Kwaspen 2017.

Figure 5. Tunic AF 12249. Detail with weft twining from waist tuck upwards. (Photo: Anne Kwaspen © Musée du Louvre).

Figure 6. Tunic AF 12249. Detail of hem with applied fringed trimming. (Photo: Anne Kwaspen © Musée du Louvre).

Figure 7. Tunic AF 12249. Detail of weave near tuck: band of brighter coloured wool just below the tuck. (Photo: Anne Kwaspen © Musée du Louvre).

The hem

As was often made on tunics, fringes are created at the hem of the tunic. As described above, in general for tunics in three parts, the lower parts of the tunic were woven in one piece and then cut in half in warp direction and turned 90° before being sewn to the upper part. The selvedges then logically become the hem of the tunic. Weft fringes can thus be woven into both selvedges.[13] These weft fringes then form the finishing on the hem of the tunic. As turned out with the neck opening and the waist seam, the way the hem of tunic AF 12249 is finished is different than would be expected. There are no selvedges visible on the hem but instead the hem has a rolled seam. A fringed trimming was sewn over that seam. This also explains why the colours of the fringes do not match the colours of weft threads that are in line with each other (fig. 6).

The waist tuck

Tunic AF 12249 has a small tuck of 1.2 cm in which the waist seam is hidden. Just below this tuck a band is visible where the colour is clearly much brighter than the bleached colours in the surrounded areas. The brighter band is not straight but wider towards the sides of the tunic (fig. 7). This kind of colour difference is often found on Egyptian wool tunics woven-to-shape and this usually indicates an opened waist tuck. These shaped, brighter-coloured bands are also visible on the other fragments of the Louvre Museum E 29306 and E 29308, and here the remains of the sewing thread to close the tuck are even preserved (fig. 2). This supports the assumption that the colour difference on tunic AF 12249 also came from an opened tuck.

The rest of the weave was examined to see if there was another similar colour difference elsewhere, and one was indeed unexpectedly found on the shoulder line (fig. 8). On this place in the tunic it is impossible that the colour differences would have occurred due to the creation of a sewn pleat, because that would mean that the neck opening would have been hidden inside this pleat.

Reconstruction of the original tunic

All the deviations compared to the usual technical features of sleeveless tunics described so far led to the assumption that this tunic was composed of cloth from another textile. However, it was by examining the unusual discoloration of the weave in the shoulder area that it became clear how another tunic was cut to create this new tunic.

13. Verhecken-Lammens 1993, p. 75–76.

Figure 8. Tunic AF 12249. Detail of shoulder-neck: band of brighter coloured wool. (Photo: Anne Kwaspen © Musée du Louvre).

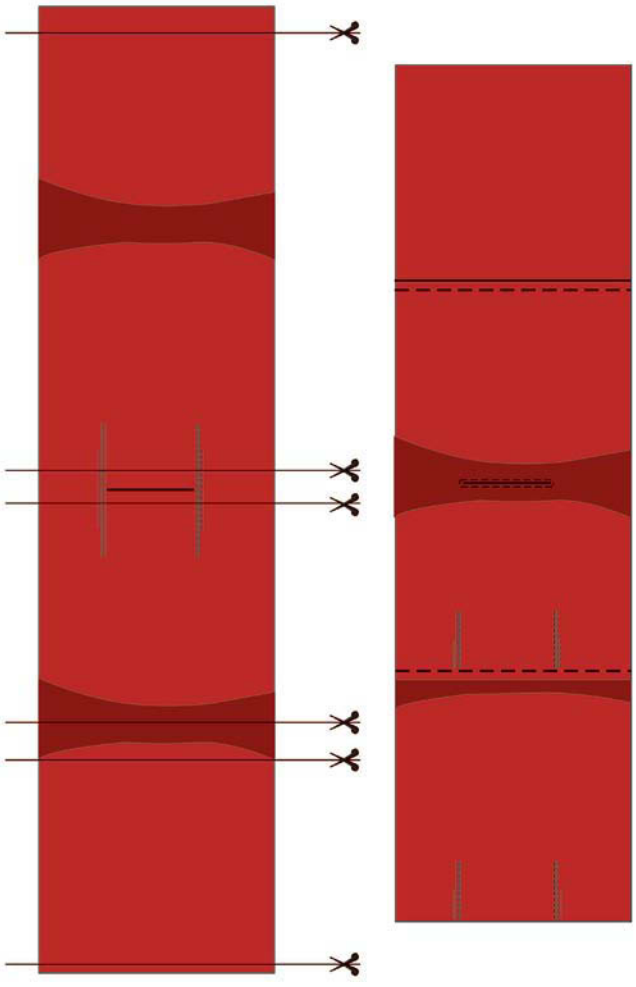

Figure 9. Drawing indicating how the original tunic was cut (left) to construct the new tunic (right). (Drawing © Anne Kwaspen).

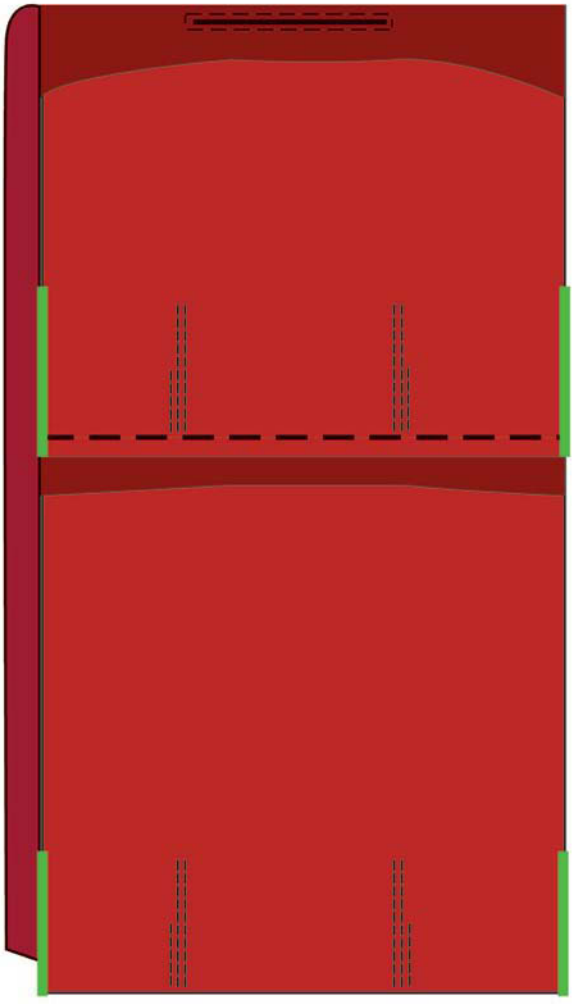

Figure 10. Drawing with green marks indicating the places with "fake" finishing borders. (Drawing © Anne Kwaspen).

One could assume that the shoulder area with neck opening of the original tunic, woven in one piece, was too damaged and the cloth of the tunic has therefore been re-used to create another tunic. According to the technical details in the newly formed tunic, the damaged tunic was cut as shown in fig. 9. The 'front' part of the original tunic became the upper part of the new tunic, in which it was necessary to cut a new neck opening. In this way, the ends of the weft twining on the shoulder-neck of the original tunic come to lie at the waist tuck. The other half of the original tunic is cut in two pieces through the opened original tuck. The skirt part is used as the skirt part of the back of the new tunic and the upper part is turned upside down and also used as a skirt part. This turning of the upper part results in the new tunic having the rows of the original reinforcement weft twining on the hem.

The new hem is finished with a rolled seam. The inside of the rolled seam on the back of new tunic could not be examined to see if a selvedge of the original hem was kept. The fringes that are sewn onto the hem could be the cut off fringes from the hem of the original tunic.

Sleeves

After determining the re-use of the cloth of a tunic to form this sleeveless tunic, the side edges of this newly formed tunic were examined. As described above, the warp yarns are worked into finishing cords, with a twisted cord on one side and a braided cord on the other. But at four places on the front side of the tunic (green marks at fig. 10) the warp cords stop and the sides there are finished with sewn-on twined cords. These four places correspond to what used to be the shoulder area in the original tunic. After further analysis of the weaving structure under these sewn-on cords, some fragments of weaving were discovered that extend beyond the 'finishing borders', indicating that the original tunic must have been a tunic with woven-on sleeves (fig. 11). However, information about the dimensions (length, width) of the sleeves cannot be retrieved anymore because part of the original shoulder-neck part is missing.

Adjustments

Many of the Egyptian tunics in museum collections show alterations and repairs. A distinction must be made between repairs executed in late antiquity and the adjustments made by art dealers or even museum staff in the 20th century. In fact, in museum collections there are many tunics (fragments) that are embellished in modern times to create more complete garments by adding trimmings, tapestry fragments and patches, but also by imitating the type of darning work that was in use in late antique Egypt.[14] To examine whether patches and darning work are original or fake, it is important to analyse the yarns used. If the weaving is made with S-spun yarns (most common in wool weaving from late antique Egypt), the sewing thread or darning thread will most probably also be S-spun. The most commonly used is S2Z as sewing thread. Finding plied Z-spun yarns indicates it is probably an adjustment from the 20th century.

Besides the fact that tunic AF 12249 was made up of re-used cloth, many repairs were also carried out on this weave (fig. 12). Large tears have been sewn and patches have been applied. Various yarns were used for the sewing,

Figure 11. Tunic AF 12249. Detail of edge of waist: fragments of weave that extend beyond the finishing borders indicating the remains of sleeves. (Photo: Anne Kwaspen © Musée du Louvre).

14. Examples of forgeries in tunics: the Louvre Museum: E26170, E26109, E27453 and E26299: published in Cortopassi 2013; Phoebus Foundation: KTN 2365: published in Kwaspen 2014, and Röhsska Museum: RKM 852–14: published in Erikson 1997, p. 77–83.

Figure 12. Tunic AF 12249. Detail of different repairs. (Photo: Anne Kwaspen © Musée du Louvre).

including both red (2S) and natural-coloured wool (S2Z) and also linen (S2Z). These natural-coloured yarns are in strong contrast to the red and green wool of the cloth, but looking at the other similar fragments of the Louvre Museum, E 29306, E 29308 and AF 5989, we see the same use of contrasting natural-coloured yarn. The use of S-spun yarn and the fact of the same colour use in the other fragments indicated that this tunic was remade in the late antique period. This was confirmed by radiocarbon dating of the weaving yarn,[15] the sewing thread[16] as well as the fringes.[17] The dating of the three samples gives a clear overlap, so we can say that both the original tunic and the later remodelled tunic date from the 7th century AD.[18]

Conclusion

With sleeveless tunic AF 12249 the Louvre Museum has a unique example in the collection of how pieces of clothing were re-used to create other garments (of a different type). Several features of this tunic do not match the features known from other sleeveless wool tunics. The technical analysis clearly indicated that this tunic was made from cloth of another tunic. By comparison with other woollen tunics – with or without sleeves – it could be determined which type of tunic the original tunic had been.

Re-use and repair of cloth are known practices from late antique Egypt and tunic AF 12249 is a remarkable example of its use in a piece of clothing for an adult person.

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15. 68.2% probability: AD 645–675; 95.4% probability (the 95.4% probability is split into 93.1% and 2.3%): 93.1% probability: AD 620–700; and 2.3% probability: AD 740–770. I would like to thank Dominique Bénazeth for sharing with me the results of the radiocarbon dating. The radiocarbon dating was executed in KIK-IRPA (Royal Institute for Cultural Heritage), Brussels, by Mathieu Boudin.
16. 68.2% probability: AD 645–680; 95.4% probability (the 95.4% probability is split into 90.0% and 5.4%): 90.0%: AD 630–710; and 5.4% probability: AD 740–770.
17. 68.2% probability: AD 615–655; 95.4% probability: AD 590–665.
18. Bogensperger 2014, p. 335–344: the article describes a tunic fragment repaired with a sleeve? used as patch, turning the woven-to-shape tunic into a sleeveless tunic? for burial purposes? I. Bogensperger also mentions ancient sources on trade in second-hand clothing. See also Morgan 2018, p. 88–97: in the chapter on reuse F.P. Morgan quotes from ancient texts on the re-use and trade of "second-hand" clothing.

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What flaws can tell: a case study on weaving faults in Late Roman and Early Medieval weft-faced compound fabrics from Egypt[1]

Barbara Köstner

Silk samites from Late Roman and Early Medieval Egypt are well-known objects in museum collections all over the world. One group of fragments, the so-called Akhmim silks, show a mechanically repeated floral pattern. More than 100 examples with this design are known; the fragments bear striking similarities in design and technique. Were they woven in the same workshop? If all or at least a large number of pieces could be traced back to several batches of production, this would lead to further insights concerning the economics of early silk weaving. A detailed analysis of two exemplary pieces reveals features that are not seen at first sight: small mounting errors or faults during weaving can be followed warp- and weft-wise. Together with the technical details these "flaws" are a fingerprint of the textile that is unique and visible in all fragments woven within the same warp on the loom. In addition, the weaving faults provide details about the weaving process and the advanced looms that were used. This paper offers an approach towards the identification and characterisation of woven-in irregularities and a perspective on the possibilities they offer to research on complex fabrics.[2]

Silks from Egypt

Among the many different fabrics that were discovered in the Roman to Early Medieval necropoleis of Egypt around the turn of the 20th century was a remarkable amount of silk textiles. In 1891 the Swiss collector and art historian Robert Forrer published his catalogue *Römische und Byzantinische Seiden-Texilien aus dem Gräberfelde von Achmim-Panopolis*, dedicated solely to the luxurious and mostly patterned silk textiles found in Akhmim.[3] Further silks from Akhmim and other find-spots in Egypt were published in early excavation reports,[4] catalogues of collections,[5] general overviews on so-called Coptic textiles or the history of silk textiles in particular.[6]

Published in Maria Mossakowska-Gaubert, ed., *Egyptian Textiles and Their Production: 'Word' and 'Object' (Hellenistic, Roman and Byzantine Periods)* (Lincoln, NE: Zea Books, 2020). doi 10.32873/unl.dc.zea.1084

1. Research on the technique of silk samites is part of my ongoing PhD project *Komplexe Seidengewebe im Gebiet des römischen Reiches aus der Spätantike und dem Frühmittelalter (3. bis 8. Jh. n. Chr.)* under the supervision of Professor Sabine Schrenk, Christliche Archäologie, Universität Bonn.

2. My sincere thanks go to the colleagues who made it possible for me to analyse some Akhmim silks in person and to take the time I needed to trace irregularities: Judith Goris and Chris-Verhecken-Lammens, formerly Phoebus Foundation / Katoen Natie, Antwerp; Anne Haslund Hansen, National Museum of Denmark, Kopenhagen; Annette Paetz gen. Schieck, Deutsches Textilmuseum, Krefeld; Imogen Liang and Amandine Merat, both British Museum, London; Mariam Rosser-Owen and Ana Cabrera-Lafuente, Victoria & Albert Museum, London; and Anu Liivandi, Royal Ontario Museum, Toronto.

This research benefits a lot from the kind support from and the brilliant technical discussions with Ana Cabrera-Lafuente, Annette Paetz gen. Schieck and Chris Verhecken-Lammens.

3. Forrer 1891.

4. *E.g.* Forrer 1895; Gayet 1897; Gayet 1898.

5. *E.g.* Hampe 1896; Kendrick 1922, Wulff & Volbach 1926.

6. *E.g.* Schulze 1920; von Falke 1913.

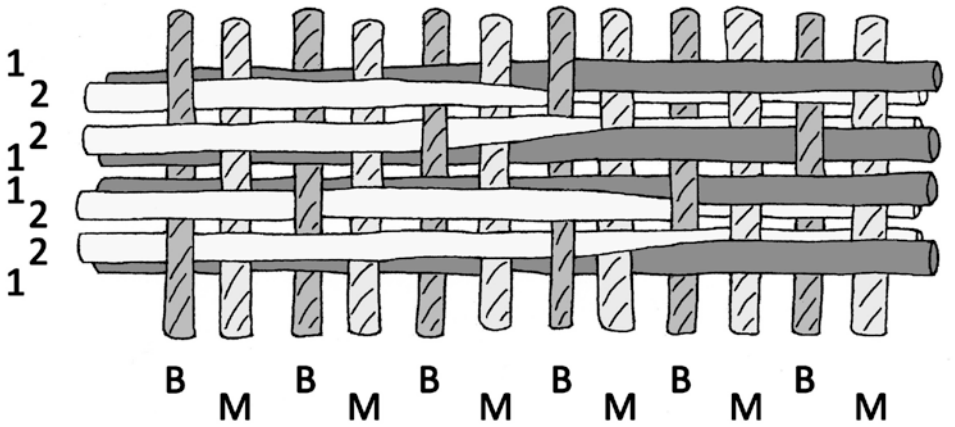

Figure 1. Samite.
B = binding warp;
M = main warp;
1 = ground weft;
2 = pattern weft.
(Drawing © Barbara Köstner)

Today the pieces are distributed around museums all over the world, particularly in the major art and textile museums and private collections. A broad, multi-disciplinary approach towards these textiles is necessary to answer the emerging questions on origin, production, distribution and use of these special fabrics.[7]

The technique of samite

One major group of silk textiles from Late Roman and Early Mediaeval times is woven in weft-faced compound twill, called samite. In this technique, two warps and two or more wefts are used to produce a fabric that shows the pattern in contrasting colours (see fig. 1). On the reverse the pattern appears in inversed colours.

Two warps are employed for the fabric: one for the 1/2 twill binding of the fabric (binding warp / Bindekette / chaîne de liage, marked "B" in fig. 1) and one for the separation of the pattern sheds (main warp / Hauptkette / chaîne pièce,[8] marked "M" in fig. 1). The warp threads with different functions lie next to each other, always one after another following the configuration B, M, B, M. This is described by the "warp proportion", which is 1:1.[9] Only the binding warp is visible on the surface of the fabric; the main warp remains unseen and is completely covered by the wefts. Two wefts of contrasting colours are used in one binding shed, and the main warp separates them to push one to the front and one to the rear side of the fabric to form the pattern.

Group of so-called Akhmim silks

The total number of silk samite fragments from the 3rd to 8th century AD in museums and private collections reaches several hundred. Groups are formed by provenience and iconography as well as by technical features. The group of the so-called Akhmim silks is named by the find-spot of Akhmim in Upper Egypt, where a number of silks with the same design have been discovered.[10] Primarily, they are dual-coloured samites with the pattern in a light cream colour on a darker background; a central motif is framed by a border of repeating elements. Following the approach of Antoine De Moor, Sabine Schrenk and Chris Verhecken-Lammens (2006), the focus of this article is set on the narrow definition of the constituent figures of this group: a central plant motif with distinct features and framing borders of alternating mirrored palmettes on all elements[11] (see fig. 2). Forrer has already noted that this floral pattern

7. A detailed overview on the history of the research on so-called Coptic textiles and a perspective for the future is provided by Thomas 2007.
8. For the vocabulary, see CIETA 1964. The term "main warp" may be misleading at first sight, as it naturally indicates the principal warp in the fabric. In samite the invisible main warp is crucial for the forming of the pattern, but has no binding function. It may be tempting to call this pattern-forming warp "pattern warp", but this term is already used for supplementary warps that are visible on the surface (synonym for pattern warp: flushing warp / Flottierkette / chaîne poil, see Burnham 1980, p. 98 and 180). Occasionally "inner warp" is used as a synonym for the main warp (Burnham 1980, p. 180).
9. As an example: some later silk samites have a different warp proportion of 1:2 meaning that 1 binding warp is followed by two main warps.
10. De Moor *et al.* 2006, p. 85.
11. For a detailed description of the pattern, see De Moor *et al.* 2006, p. 85–88; the only difference the author would like to suggest is to reinterpret what De Moor *et al.* called "large leaves" (p. 85) as "buds".

Figure 2. Roundel, silk, 22.3 x 22.5 cm: Victoria & Albert Museum, Inv. No. 355-1887. (Photo © Victoria & Albert Museum).

occurs very often and might have been very popular in Akhmim.[12] Currently more than 100 samites with this special iconography are known from different collections.[13]

An advanced division of the Akhmim silks with plant motif can be made regarding the stylistic differences formed by a larger warp step. In pieces with very fluent pattern and organic appearance every thread of one pattern unit of the main warp was operated singly (warp step = 1). These pieces can easily be distinguished from those with a highly stylised appearance, which is formed by small pixel-like

12. Forrer 1891, p. 16.

13. De Moor *et al.* 2006, p. 88–89 list 20 pieces with verified find-spot and a further 43 pieces of this group with no verified find-spot. To these 63 examples can be added 40 pieces from the author's recent research; it is most likely that more pieces will be added to the list. A broader view of this group of silks is held by Forrer 1891 p. 14–16; von Falke 1913, p. 43–47; Martiniani-Reber 1986, p. 80–81 and Muthesius 1997, p. 81, who include similar dual coloured samites with figural depictions in roundels and *clavi* and heart-shaped framing ornaments.

Figure 3. Linen tunic with sewn-on silk panels, height 137.2 cm, width: 210.5 cm incl. sleeves, width of hem: 110 cm: Victoria & Albert Museum, Inv. No. 820-1903. (Photo © Victoria & Albert Museum).

blocks, where the threads of the main warp were operated in groups (warp step = 3 or more).[14] Further technical details differ between the organic and the stylised group, such as the direction of twill, weft proportion and weft sequence, as well as weft density.[15]

Use

The Akhmim silks with plant motif are found in different shapes: roundels that have been cut close to the edge of the medallion;[16] panels that have been cut from the fabric in a rectangular shape showing the remains of rosette ornaments in the angles between the medallions;[17] *clavi* with round pendants at the ends;[18] and large rectangular decorations with a central floral circle ornament and mirrored horsemen.[19] Traces of sewing and seam allowances indicate that the different elements were used mainly as decorations for tunics.[20] One complete garment now in the Victoria & Albert Museum, London (fig. 3), shows a set of two *clavi*, four *orbiculi* and two *manicae* sewn onto a plain

14. De Moor *et al.* 2006, p. 92. The grouping of main warp threads in blocks (= larger warp step) leads to a loom-setup where the weaver has to handle only c. 40–60 pattern blocks instead of more than 200 single main warp threads per pattern unit.
15. See analysis by Chris Verhecken-Lammens in De Moor *et al.* 2006, Table 2, p. 93. The author's research on further pieces backs these findings.
16. *E.g.* Nürnberg, Germanisches Nationalmuseum, Inv. No. Gew350 (Hampe 1896, no. 350); Victoria & Albert Museum, Inv. No. 355–1887; 2066–1900 (Kendrick 1922, no. 798).
17. *E.g.* Wien, MAK, Inv. No. T 10051–01–1953 (Noever 2005, no. 114); Phoebus Foundation, Inv. No. 657 (De Moor *et al.* 2008, p. 194–195).
18. *E.g.* Deutsches Textilmuseum, Inv. No. 00120A (Paetz gen. Schieck 2003, no. 217).
19. *E.g.* Victoria & Albert Museum, Inv. No. 303–1887 (Kendrick 1922, no. 800).
20. Only a few pieces exist that do not fit the standard scheme of rectangular or circuit panels and show several roundels in one larger piece of fabric, *e.g.* Washington, Dumbarton Oaks, Byzantine Collection, Inv. No. BZ 1977.2 (Thomas 2017, p. 65, fig. 5.22) which shows four complete and four half roundels in one large sheet.

white linen tunic.[21] This singular tunic is a surviving example of the Akhmim silks in their original context and shows the use of the panels. It is remarkable that the sleeve panels were woven with a mirrored design for the horsemen to be in the correct viewing position on both sides of the sleeves when the tunic was worn.

Colour and dating

While the most common background colour of Akhmim silks with plant motifs is a purple hue, blue, green, red and orange tones were used as well. The pattern wefts are in cream or light yellow. Ten examples have been tested for the dyestuffs used in the weft, and all examined examples showed traces of redwood as dyestuff, albeit the organic group of samites showed a broader range of colours mixed for the purple tones, including madder, indigoid, lac and tannin besides redwood.[22] The warp threads can be of brown or yellow colour, consistent within one piece.

The common stylistic dating assigned these pieces to the 6th–10th century AD.[23] This was narrowed by the ^{14}C-dating of ten pieces which resulted in a dating from AD 650–948 (95% probability) with an interquartile dating range for all ten fabrics of AD 687–828, with the organic type pieces dating slightly earlier than the stylised ones.[24]

Economic relevance

Looking at the similar patterns of the Akhmim silks with plant motif and the large number of surviving pieces, a most pertinent question is whether they were produced by the same or related workshops and where these could have been located. It is certain that the Akhmim silk panels were not woven as individual items but were cut from a length of fabric with a repeating pattern.[25] The fabric produced on one loom with one warp can be regarded as one single batch of production. But the technical details alone may not suffice to prove the origin from one single batch since the overall technical features of two batches may be close to identical. To prove the affiliation of pieces to the same batch, a detailed analysis must detect irregularities in the pieces. Every silk fragment contains features that are not seen on first sight, such as mounting errors or faults during weaving that can be followed through the whole piece. These "flaws" are visible in all fragments woven within the same warp and are a "fingerprint", an individual marker of one batch.[26] Reconstructing the possible batches of Akhmim silks with plant motives would help to estimate the output of the silk weaving workshops and lead to further conclusions concerning the economics of early silk weaving.

Technical details of Akhmim silks in organic style

The proportion of warps in the Akhmim silks in organic type is 1:1, with alternating binding and main warp threads (see fig. 1).[27] For both warps, single threads of silk with a twist in Z-direction were used. The twill binding is a 1/2 twill in straight Z-direction. The width of the main warp is divided into several pattern units, which are each about 11 cm wide and have a reverse repeat (double point) with a warp step of 1. One roundel consists of two pattern units with the mirror axis in the centre. It is still not certain how many pattern units were employed in one loom-width, but it may be eight pattern units, arranged in point repeat - or even more.[28] The warp density is measured in units (here: 1 binding warp thread + 1 main warp thread = 1 warp unit) and ranges from 16-22 units/cm.

Two wefts of contrasting colours (ground weft = 1 and pattern weft = 2 in fig. 1) are used for each binding shed, separated by the main warp. This combination of two

21. Victoria & Albert Museum, Inv. No. 820–1903, purchased in 1903 from L. Paul Philip, located in Cairo. Archive of the Victoria & Albert Museum, Museum Register No. 193, Science & Art Department, MA/30/227, p. 270 and Nominal File MA/1/P/109.
22. De Moor *et al.* 2006, table 3, p. 94.
23. Muthesius 1997, p. 81.
24. De Moor *et al.* 2006, p. 91. A silk samite with a more general Akhmim-like style from Avdat, Israel, backs this dating with a secured archaeological context dated to *ante quem* 636, see Baginski & Tidhar 1978.
25. Selvedges appear only on rare occasions and so far only on one side of a panel, *e.g.* Phoebus Foundation, Inv. No. 0842. Some panels show parts of the pattern of the next roundel in the seam allowance, *e.g.* Deutsches Textilmuseum, Inv. No. 00124, see Paetz gen. Schieck 2003, no. 216, p. 104.
26. Ana Cabrera suggested that warp errors due to miscounting would possibly continue in a knotted-on warp. Whether the knotting-on of a new warp to an old one was possible and practised in Late Roman to Early Medieval samite weaving is yet to be researched.
27. They are also known as single main warp twills; see Muthesius 1997, p. 81.
28. The piece at Dumbarton Oaks Byzantine Collection, Inv. No. BZ 1977.2, shows four roundels in the width of the warp.

threads is one pass (fig. 1 shows four passes). The weft step is two passes for the organic designs, with a special way to insert the thread; the selection of the pattern shed is used for two consecutive binding sheds in the rhythm of 1,2/2,1 (see fig. 1). This technique employs two shuttles for each colour.[29] The weft threads of the Akhmim silks show no twist; weft density varies from 20-44 passes/cm.

Tracing pieces from the same warp

When tracing pieces that might have been woven in the same warp, they should first meet the following criteria:

Same technical features:

- Warp proportion
- Warp step (distinction between organic and stylised examples; within the stylised examples further differentiation is possible)
- Twill direction (the twill direction might be changed during weaving, but this seems unlikely so far)
- Twist and colour of warp threads
- Thread count
- Colour of weft (this applies weft-wise; of course it would be possible for the weaver to change colour of wefts in the length of one warp).

Due to several factors, like the application of the panels on a fabric, the time spent in the soil and conservation treatment, the warp and weft density may change slightly as could the colours. These parameters should, however, lie within a considerably narrow range.

Same design:

- Special attention should be given to small details that may differ.

All silks in this focus show a design with plant motifs and framing border with mirrored palmettes.[30]

If the above criteria are all met, it is a strong indicator, albeit not a proof, of pieces belonging to the same batch. To provide complete certainty that two (or more) textile fragments derive from the same warp, it is necessary to see if there are irregularities in the fabric and if these irregularities match one another.

Irregularities

With such a complex technique and fine weaving as silk samite, it is almost inevitable that irregularities appear. Every stage of the weaving process is prone to small mistakes that will not have a dramatic effect on the fabric as a whole and will only be discovered with a very close look.[31]

These irregularities can be detected by a simple non-invasive visual analysis. Intact and damaged fragments can be examined: thread-counter and (digital) microscope are useful instruments.[32] As part of the common analysis of a fabric (cutting marks, seam allowances, sewing traces etc.) and its technical features, warp and weft are systematically searched for irregularities.

When detecting such irregularities, it is necessary to trace them in the full length of the thread (warp- or weft-wise). Some irregularities occur during weaving, like broken and therefore missing warp threads, and these will not show in the full length of the warp. Other irregularities, like a change in the twill direction, are mistakes during the mounting of the warp and will be visible through the full length.

Irregularities that occur weft-wise always appear exactly in the same position in the pattern (= same shed). If the wrong main warp threads are picked in a pattern shed or the weaver forgets to insert one of the wefts, this will repeat weft-wise in all fragments woven next to each other in the same warp.

During analysis, the position of all irregularities is noted precisely. The position of warp irregularities should not only be noted in centimetres but also in the number of warp steps in relation to the next pattern marker.

Different kinds of irregularities may occur:[33]

29. For a detailed description, see Chris Verhecken-Lammens in De Moor *et al.* 2006, p. 92–93.
30. There are indications that *clavi*, *orbiculi* and *manicae* of one design could have been woven within the same warp; see forthcoming articles by the author.
31. In textile production the examination of the fabric and detection of irregularities is a standard procedure of quality control. While the literature focuses mainly on modern textile production, it is useful for textile archaeologists as well; see for example Herzog & Koch 1958.
32. Beside this common set-up for analysis, Julia Galliker developed a promising application of computer vision for the analysis of weft-faced compound fabrics, which works with high resolution digital images from intact areas of textiles. It requires a set of digital instruments to capture images of a very high standard, which are then processed with a specialised software; see Galliker 2013.
33. As the research is ongoing, further points may be added to the list.

Irregularities of the basic material:

- Diameter of warp and weft threads
- Strength of twist of the thread
- Colour of the threads

Irregularities that occur before the actual weaving (warping, mounting):

- Miscounting during the warping or mounting (*e.g.* double or missing warp threads—not to be confused with broken warp threads—or wrong number of threads in blocks of stylised patterns).
- Misthreading: One or several warp ends are not threaded in the correct order, the wrong shed/heddle is chosen (*e.g.* change in twill direction when binding warp is affected).

Irregularities that occur during the weaving:

- Broken warp threads: one binding or main warp thread is missing; the two warp ends of the other system are lying next to each other. This irregularity can be mistaken as a miscounting in mounting. In some cases the replacement of a broken warp thread can be detected.
- Floating warp threads.
- Wrong selection of pattern shed: errors in the pattern that repeat in the next pattern unit.
- Wrong selection of binding shed.
- Double wefts:
  - True double (*e.g.* the same pass woven twice in the same binding shed).
  - Double thread in same shed at end of bobbin (overlapping ends).
- Missing wefts: only one weft has been inserted; the second pattern shed of the pass is empty.

Mapping these "flaws" leads to an individual pattern of irregularities, which clearly indicates related pieces woven within the same warp.

Testing the method

During research on pieces from different museum collections, two fragments were found that appear nearly identical:[34]

a) Panel from the Victoria & Albert Museum, Inv. No. 303-1887, 33 x 23.4 cm, fig. 4.

b) Panel from the British Museum, Inv. No. 1904,0706.41, 30.1 x 22.9 cm, fig. 5.

Both fragments bear the design of the plant-motif Akhmim silks. They are worked in the organic style and show the same pattern: in the lower half, two horsemen face each other divided by a line of pomegranates. Above the riders, the inscription ZAXAPIOY (Zachariou) is woven in Greek letters in the correct reading direction on the one side and mirrored on the other side.[35] The upper halves of the pieces show a lavish pattern of tendrils and buds with a central flower. The right and the left borders are framed with the typical mirrored palmette patterns. There are no selvedges; all sides (except for the fringed end of the Victoria & Albert piece) have been cut.

In comparison with the silk decorations on the tunic, Inv. No. 820-1903, at the Victoria & Albert Museum, the pieces can be identified as halves of sleeve panels. Did they once belong together? The cutting lines in the middle of the central floral ornament seem to correspond, as do the technical features:

	British Museum, Inv. No. 1904,0706.41	*Victoria & Albert Museum, Inv. No. 303-1887*
Warp		
1/2 Twill, direction	Z	Z
Twist BW, MW	Z,Z	Z,Z
Colour BW, MW	brown	brown
Proportion	1:1	1:1
Units/cm	18-20	18-20
Warp step	1	1
Warp steps*	215-220	215-220
Weft		
Twist	none	none
Colour	1:purple to blue (ground) 2: cream (pattern)	1:purple to pink (ground) 2: cream (pattern)
Proportion	2/2	2/2
Sequence	1,2/2,1	1,2/2,1
Weft step	2	2
Pass/cm	33-44	35-40

* The total number of warp steps is difficult to count, as due to the cutting to the left and right no full pattern unit is preserved. However, separate pattern elements, like borders or figural fields, have been counted and proven to be identical.

34. I am much obliged to the staff of the British Museum and the Victoria & Albert Museum who made it possible for me to see both pieces simultaneously in December 2018. This was only possible due to the lucky circumstance that both pieces were located at Blythe House in Kensington, London. Thanks for making the unusual meeting possible are due to: Claire Allen-Johnstone, Benjamin Hinson, Suzanne Smith and Mariam Rosser-Owen, all Victoria & Albert Museum and The Clothworkers' Centre, as well as Imogen Laing and Amandine Merat, both British Museum.

35. For the interpretation, see De Moor *et al.* 2006, p. 88 with further references.

Figure 4. Panel, silk, 33 x 23.4 cm: Victoria & Albert Museum, Inv. No. 303-1887. (Photo © Victoria & Albert Museum).

Figure 5. Panel, silk, 30.1 x 22.9 cm: British Museum, Inv. No. 1904.0706, 41. (Photo © Trustees of the British Museum).

For the reconstruction of the full panel, the pieces are joined at the cutting line, turning the British Museum piece through 180° and placing it on top of the Victoria & Albert piece. The measurements in the following paragraph relate to this new set-up (see fig. 6).

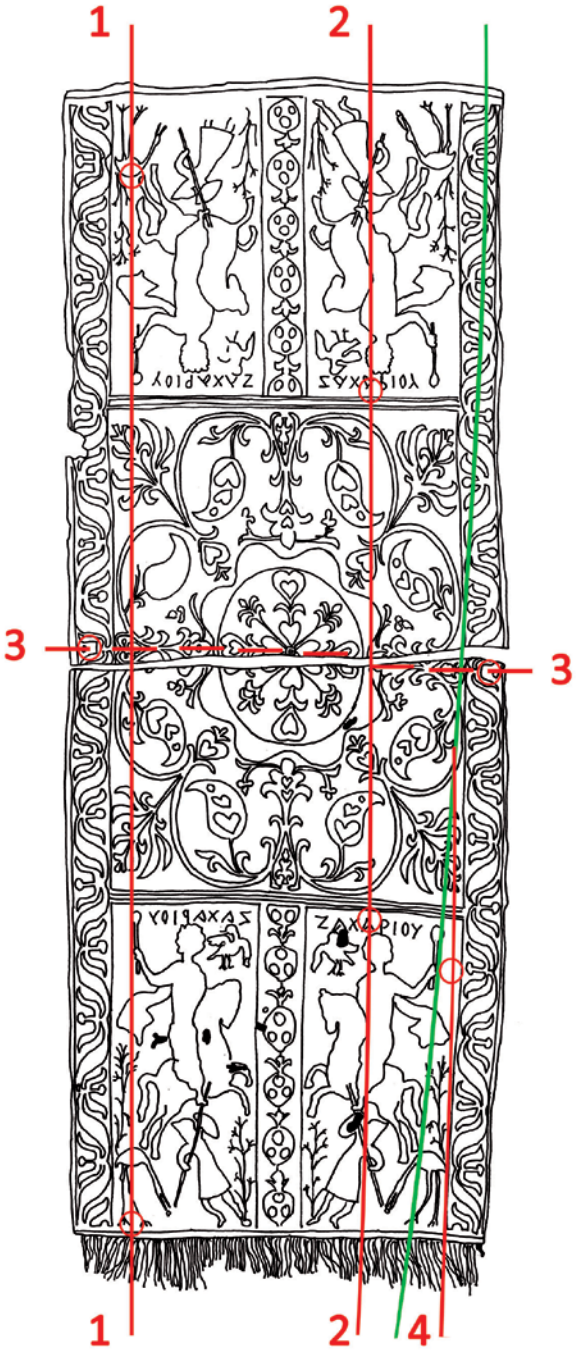

Figure 6. Sketch of the position of corresponding irregularities (red lines, 1-4) and line of wear (green) in the two pieces: British Museum, Inv. No. 1904.0706,41 (upper half) and Victoria & Albert Museum, Inv. No. 303-1887 (lower half); red circles indicate the position of the details. (Drawing © Barbara Köstner).

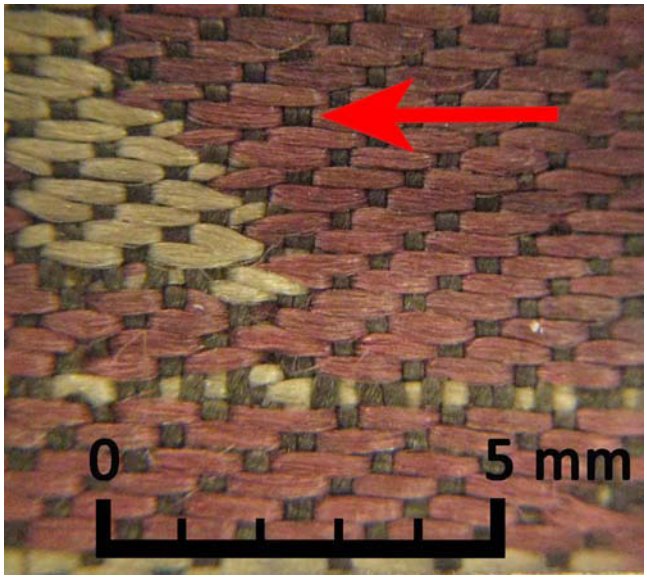

Figure 7a. Double binding warp thread in Victoria & Albert Museum, Inv. No. 303-1887. (Photo: Barbara Köstner © taken courtesy of the Victoria & Albert Museum).

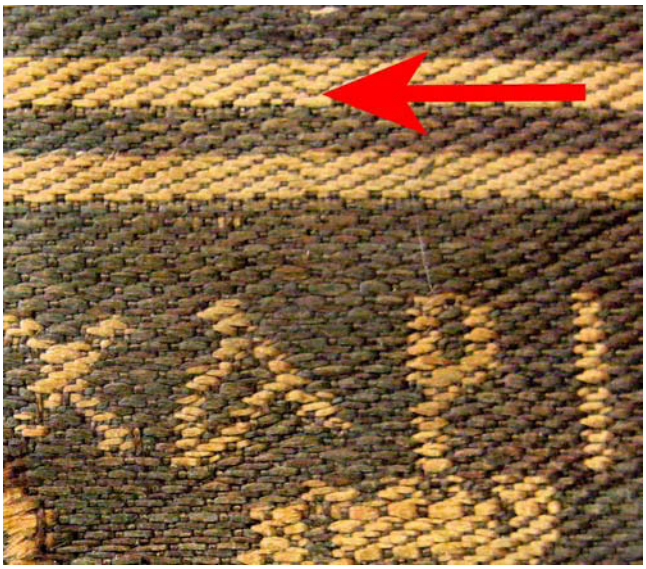

Figure 8a. Change in twill direction in Victoria & Albert Museum, Inv. No. 303-1887. (Photo: Barbara Köstner © taken courtesy of the Victoria & Albert Museum).

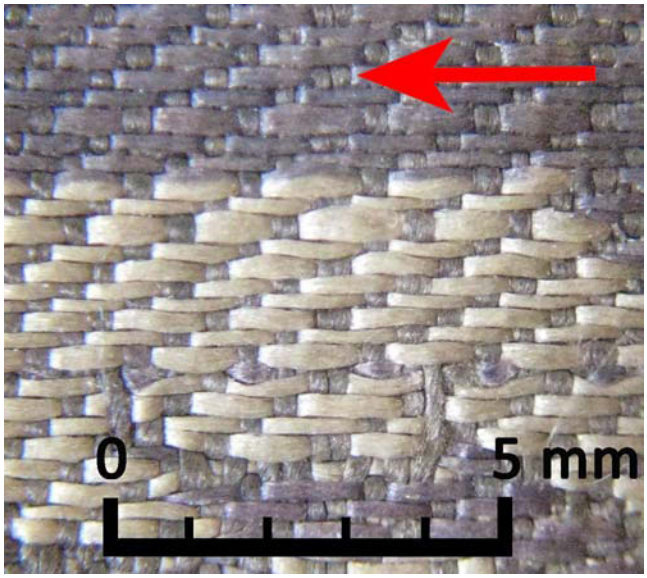

Figure 7b. Double binding warp thread in British Museum, Inv. No. 1904.0706, 41. (Photo: Barbara Köstner © taken courtesy of the Trustees of the British Museum).

Figure 8b. Change in twill direction in British Museum, Inv. No. 1904.0706, 41. (Photo: Barbara Köstner © taken courtesy of the Trustees of the British Museum).

A closer look at the weaving irregularities gives the final proof of their relation. As the cutting line runs through the warp, it is necessary to look at all irregularities in the warp first:

1. Double binding warp thread (fig. 7a+b): 1 cm right of the left framing border and into the area with figures, thread No. 20 is double. This double binding warp is the result of an irregularity during the mounting of the loom (miscounting). It is impossible that this double binding warp thread is the result of a broken main warp thread, as both binding warp threads are operating in the same binding shed.
2. Change in twill direction (fig. 8a+b): In the left figured field, 4.8 cm before the right framing border starts (right side of second "A" of the inscription, binding warp threads No. 90+91 to the right from the middle

pattern axis), a change in twill direction can be seen. This irregularity is a result of misthreading during mounting. The warp ends have been threaded in the wrong heddle. The normal count of a straight 1/2 twill repeat is 1,2,3,1,2,3,1,2,3,... while in this small area the count is 1,2,3,2,1,3,1,2,3,....

Neither of the pieces contains further irregularities in the warp that are consistent throughout the full piece or appear in the middle section where both pieces once were joined. As the cutting line is curvy, weft-wise irregularities in this area should also match:

3. Double weft (fig. 9): The pattern has a horizontal mirror axis in the centre of the floral motif. The last cream weft of the upper pattern half of the panel is inserted double in the pattern shed and therefore shows as a thick cream weft. This is visible on the lower edge of the British Museum piece and, as a result of the curvy cutting, at the very top of the right side of the Victoria & Albert piece.

As a result of the matching irregularities, it can be proven that both pieces were woven within the same warp as one decoration unit.

One irregularity gives further indications as to weaving details:

4. Broken and replaced binding warp thread (fig. 10): While the British Museum piece is intact in this area, in the Victoria & Albert piece the usual brown binding warp 0.5 cm right of the left framing border and into the area with figures (thread No. 9 of left pattern field) ends in the central motif 4.7 cm after the horizontal mirror axis. After 11.5 cm, with floating wefts, it is replaced by a blue warp thread, which runs all the way until the fringed lower end of the piece. It seems that the weaver repaired the broken thread with what he had at hand, even if the colour did not match perfectly. This repair leads to the conclusion that the weaving of the full panel started with the riders of the British Museum piece, and the Victoria & Albert part of the sleeve panel was woven second. The fringes below the horsemen of the latter might indicate the end of the warp.

In addition to the conclusion that both pieces were woven as one decorative unit, the weaving direction can be identified.

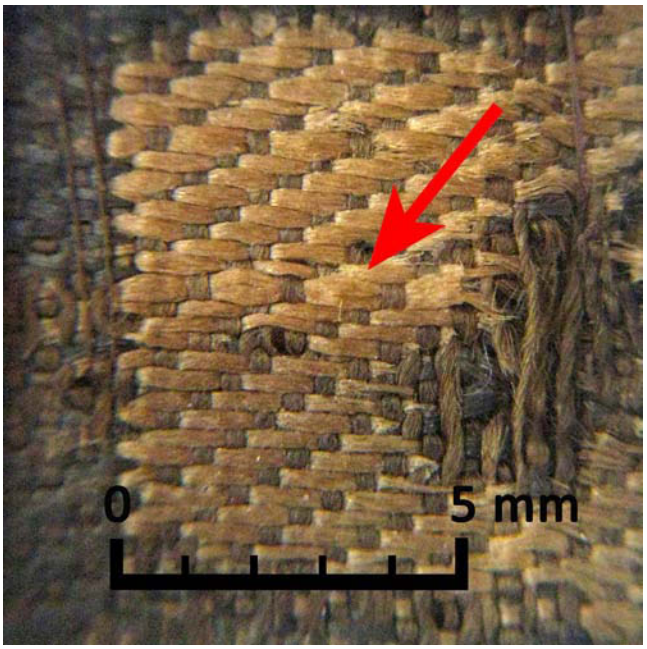

Figure 9a. Double cream weft in Victoria & Albert Museum, Inv. No. 303-1887. (Photo: Barbara Köstner © taken courtesy of the Victoria & Albert Museum).

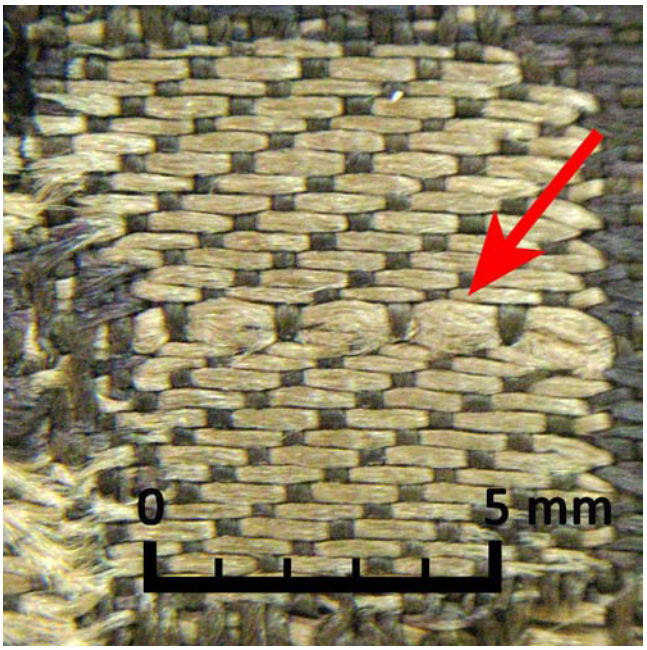

Figure 9b. Double cream weft in British Museum, Inv. No. 1904.0706, 41. (Photo: Barbara Köstner © taken courtesy of the Trustees of the British Museum).

36. Due to the mounting of the pieces the reverses were not accessible.

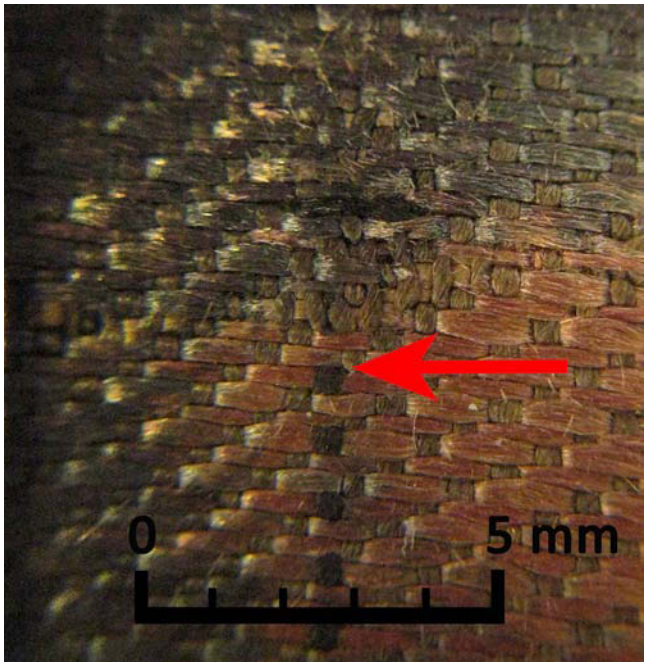

Figure 10. Broken and replaced binding warp thread in Victoria & Albert Museum, Inv. No. 303-1887. (Photo: Barbara Köstner © taken courtesy of the Victoria & Albert Museum).

But when were the pieces cut? As the sewing threads have been removed and the seam allowances of both pieces have been evened out, only very small remains and a few holes left by sewing threads have been detected on both pieces.[36] The traces of sewing run along the left and right edges of the border and below the riders. In both pieces, 0.5–1 mm long stitches with 5–7 mm distance were found with sewing thread in a cream silk plied in S-direction from two thin silk strands. A horizontal line of wear close to the middle of the central field in the British Museum piece corresponds to traces of a sewing line placed immediately below and seen in the middle of the large sleeve panels on the Victoria & Albert tunic, Inv. No. 820-1903. This line only appears on the British Museum piece; the upper edge of the Victoria & Albert half of the sleeve panel does not show any sewing traces. Further traces of wear indicate that the two objects have been exposed to pressure and wear as a unit. One line of wear runs through both pieces at the right side, moving towards the right border (see green line in fig. 6). These observations would lead to the suggestion that the pieces have been used and most probably applied to a tunic as a unit.

A look into the records of the fragments suggests that the pieces might have been cut in rather modern times: both panels were bought from the same collector, Henry Wallis, a painter, traveller, art collector and dealer from Biggin Hill, Norwood, London. He sold the first piece to the Victoria & Albert Museum, then South Kensington Museum, in 1887.[37] Seven years later, in 1904, the same Henry Wallis sold the second piece to the British Museum.[38] It is yet not possible to decide whether the pieces were already separated when Wallis bought them in Egypt.[39]

Conclusion

This small example shows what the method is capable of. While the detailed technical data gives first hints as to the relationship of fragments with the same design, the unique pattern of irregularities proves they were woven in the same warp and belong to the same batch of fabric.

Tracing these batches helps to answer questions on the technically advanced looms used for silk samites. What was the width and length of the silk fabrics and how many pieces of tunic decoration could have been woven in one batch? How many batches were necessary to produce the variety of silk decorations? The relationship and differences between batches of the same design can also give clues regarding different weavers, looms and workshops. This could help to quantify the output of one workshop. At this stage we do not know what exactly the looms for weft-faced compound twills looked like and how they actually worked,[40] but the technical analysis of irregularities helps to reconstruct them.

37. Archive of the Victoria & Albert Museum, Museum Register No. 105, Science & Art Department, MA/30/139, p. 167 and Nominal File MA/1/W330/2. The Nominal File did not reveal the origin of the textile, although the Registry states it was bought in Akhmim.

38. Remark in the entry of the British Museum's online collection, available at: https://www.britishmuseum.org/research/collection_online.aspx (last checked: 1/3/2019).

39. A visit to the British Museum's archive and the Bodleian Library, which holds Henry Wallis' papers and letters, may reveal further information.

40. No looms or written sources on the design of the looms are preserved for weft-faced compound twill from Late Roman to Early Medieval times. However, pattern looms from Han-Dynasty China are known through recently excavated and reconstructed models from Chengdou, 2nd century BC (Zhao *et al.* 2017). Ethnological evidence for weaving weft-faced compound tabby is the *zilu* loom from Iran; see Thompson & Granger-Taylor 1996. See also Sheng 2017.

By finding out more about the technique and the looms for silk samite, the evolution of this weaving technology becomes tangible. One of the main goals of this archaeological research is to find information on the place of production of these western silk samites and the specialised looms and weavers connected to it. Combined with other methods, such as the analysis of dyestuffs, ^{14}C dating, iconographic analysis and research on the written documents as well as on the provenance of these fabrics, the outcome of this method helps to discover information on the possible origin of the silk samites.

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Part III
Dyeing: terminology and technology

Ancient Greek dyeing: a terminological approach[1]

Peder Flemestad

Introduction

The *Oxford English Dictionary* defines dyeing as: "to impregnate (any tissue or the like) with a colour, to fix a colour in the substance of, or to change the hue of by a colouring matter".[2] In ancient Greek this operation is in general expressed by the verb βάπτειν, but the process of dyeing could be designated by a multitude of other terms. The following contribution provides an overview of the extensive ancient Greek terminology for the action of dyeing. The focus therefore lies primarily on the verbs designating the dyeing process itself, while wider dye terminology is only occasionally touched upon. Furthermore, the discussion does not include terms for preliminary or auxiliary processes such as *e.g.* the preparation of dyestuffs or mordanting.[3] The investigation is based on studies of ancient and modern lexica, and the terms are found throughout ancient Greek literature, both in Archaic, Classical, Hellenistic, and Imperial Greek texts, in a wide range of genres, including the lexicographers of the Second Sophistic, as well as their successors in Byzantine lexicography. The lexicographical works of the Byzantine era must be included since they preserve valuable information on more ancient vocabulary, much of which is only attested through them. The present study makes no claim to be exhaustive, but may hopefully serve as a basis for more comprehensive future studies.

Terminology[4]

ἀνθίζειν

The verb ἀνθίζειν derives from ἄνθος, 'flower'.[5] It is attested in several passages in connection to colouring, but in contexts not directly related to flowers or to dyeing: a passage in the *Electra* of Sophocles (5th century BC) speaks of a man with white hair,[6] in Herodotus (5th century BC) it is used of the colours of battlements,[7] and in a fragment of the comic poet Epicrates (4th century BC) the verb is used of the colour of roasted meat.[8] These diverse uses of the verb suggest that they are semantic extensions from an

Published in Maria Mossakowska-Gaubert, ed., *Egyptian Textiles and Their Production: 'Word' and 'Object' (Hellenistic, Roman and Byzantine Periods)* (Lincoln, NE: Zea Books, 2020). doi 10.32873/unl.dc.zea.1085

1. I thank Jerker Blomqvist, Marie-Louise Nosch, and the anonymous reviewer for their generous help and comments on an earlier version of the text; of course, any remaining errors are my own responsibility. Translations of literary texts are unless otherwise noted taken from the Loeb editions. Abbreviations to Greek authors follow those in the *LSJ*, for Latin ones the *OLD*. To avoid unnecessary repetition, the reader may, unless otherwise stated, refer to the definitions of the terms in the *LSJ*.

2. *OED s.v.*: 'dye'.

3. See Bogensperger & Rösel-Mautendorfer 2020, this volume, for terms related to dyestuffs and mordants used in textiles attested in the Greek papyri of Egypt.

4. The terms follow in alphabetical order.

5. Beekes 2010, p. 104–105: tentatively from the Indo-European root *h_2end^{h}- 'sprout'; cf. Chantraine 1999, p. 89–90.

6. S. *El.* 43: ὦδ' ἠνθισμένον.

7. Hdt. 1.98: προμαχεῶνες ἠνθισμένοι φαρμάκοισι.

earlier sense of dyeing. Nevertheless, it is only explicitly attested in the sense of dyeing – with the prefix ἐξ- – in the *Suda* (c. AD 1000).[9] It is, however, attested together with βάπτειν in the *Historia Animalium* of Aristotle (4th century BC) where the description of the murex states that when the gland is extracted and squeezed, it dyes and imparts the lustre of its bloom to the hand.[10] The connotation of lustre is shared with the noun ἄνθος itself, equally used of both dyes and the sheen of colours,[11] as well as the adjective ἄνθινος which was used of dress in the sense 'bright-coloured'.[12] A precise interpretation of the verb is therefore often impossible; it and related words are regularly used in connection with colouration, but it is difficult to ascertain whether they refer to dyeing, or rather denote decorated garments, *e.g.* with embroidery, perhaps originally embroidered floral patterns.[13] Conversely, the word βαφή could also be used for the colour of flowers.[14]

βάπτειν

The verb βάπτειν 'to dip, immerse' is clearly the default verb for 'to dye' in ancient Greek. It is attested in all periods in this sense, excepting Mycenaean, and it lives on in Modern Greek βάφω. Its etymology is unclear, but has been explained as derived from **gwḫ$_2$b^h-i̯e-* and connected with Proto-Germanic **kwēbjan-* 'to suffocate, choke'.[15] The verb strictly speaking means 'to dip, immerse', and thence 'to temper, dye, wash, soak'. It is thus not exclusively used of dyeing, and its first attestation is in the *Odyssey,* where a smith tempers iron in water, providing an early example of Greek cross-craft terminology.[16] The verb is widely attested in all periods, but its earliest attestation in connection to dyeing is in a fragment of the Epic Cycle (c. 7th-6th century BC) describing how Aphrodite prepares herself for the judgment of Paris and had clothed herself in garments that had been dyed in flowers of spring.[17] There are, moreover, compounds of βάπτειν with various prefixes and some variation in meaning:[18] ἐπιβάπτειν 'to immerse; to cure, dye; to gild'; καταβάπτειν 'to immerse; to dye, colour'; μεταβάπτειν 'to change colour by dyeing'; the most notable one is παραβάπτειν 'to dye at the same time and to obtain different colours'.[19]

8. Epicr. *fr.* 6: κρέα πυρὸς ἀκμαῖς ἠνθισμένα; it is, unsurprisingly, also used of spices, e.g. Galen (2nd century AD), 19.81.

9. Suid. *s.v.*: ἐξανθίζω· τὸ βάπτω.

10. Arist. *HA* 547a: τὸ δὲ χρῶμα ἰδεῖν ὥσπερ ὑμὴν λευκός, ὃν ἀφαιροῦσιν· θλιβόμενος δὲ βάπτει καὶ ἀνθίζει τὴν χεῖρα. The interrelation between βάπτειν and ἄνθος is of course also patent in the fragment quoted below (n. 17), where the clothing of Aphrodite had been dyed in flowers of spring (ἔβαψαν ἐν ἄνθεσιν εἰαρινοῖσιν). The final lines of the fragment add an additional aspect of the dyes: they confer not only lustre and colour, but also the fragrance of the flowers: Cypr. *fr.* 5 (West), 7–8: Ἀφροδίτη ὥραις παντοίαις τεθυωμένα εἵματα ἕστο.

11. Cf. *Anecdota Graeca* (Bekker), 404, 24: ἄνθος· τὸ χρῶμα καὶ τὸ βάμμα τοῦ ἐρίου.

12. Cf. the sense of the corresponding Latin adjective *floridus* in *e.g.* Plin. *Nat.* 35, 30, xii: *Sunt autem colores austeri aut floridi. utrumque natura aut mixtura evenit,* "Some colours are sombre and some brilliant, the difference being due to the nature of the substances or to their mixture".

13. The sense of embroidery is *e.g.* clear in Philostratus the Elder (2nd–3rd century AD), *Im.* 1.15.2. For embroidered floral patterns, cf. *e.g.* Plato (5th–4th century BC), *R.* 557c: ἱμάτιον ποικίλον πᾶσιν ἄνθεσι πεποικιλμένον. See Droß-Krüpe & Paetz gen. Schieck 2014 for a recent study of ancient embroidery.

14. Lucian (2nd century AD), *DMort.* 18.2.

15. See Beekes 2010, p. 200; Kroonen 2013, p. 315; cf. Chantraine 1999, p. 164.

16. Hom. *Od.* 9.392: ὡς δ' ὅτ' ἀνὴρ χαλκεὺς πέλεκυν μέγαν ἠὲ σκέπαρνον | εἰν ὕδατι ψυχρῷ βάπτῃ (...). Cf. *e.g.* βαφή in the sense of 'dipping of red-hot iron in water' in Sophocles, *Aj.* 651, but also 'dye' in Theophrastus (4th–3rd century BC), *HP* 4.6.5.

17. Cypr. *fr.* 5 (West), 1–2: εἵματα μὲν χροὶ ἕστο τά οἱ Χάριτές τε καὶ Ὧραι | ποίησαν καὶ ἔβαψαν ἐν ἄνθεσιν εἰαρινοῖσιν; cf. West 2013, p. 75.

18. The variant ἀναβάπτειν 'to dip, dye' is attested from the late Byzantine period onwards. Its only possible attestation in classical sources was an unnecessary variant reading in Theophrastus (*HP* 3.13.6); cf. Amigues 2003, p. 169, n. 13.

19. Plutarch (1st–2nd century AD): *Phoc.* 28.2–3: πρότερον μὲν οὖν ὀλίγοις ἔτεσι χρησμὸν ἐξήνεγκαν αἱ Δωδωνίδες τῇ πόλει "τὰ ἀκρωτήρια τῆς Ἀρτέμιδος φυλάσσειν," ὅπως ἄλλοι μὴ λάβωσι· τότε δὲ περὶ τὰς ἡμέρας ἐκείνας αἱ ταινίαι μέν, αἷς περιελίττουσι τὰς μυστικὰς κοίτας, βαπτόμεναι θάψινον ἀντὶ φοινικοῦ χρῶμα καὶ νεκρῶδες ἀνήνεγκαν· ὃ δὲ μεῖζον ἦν, τὰ παραβαπτόμενα τῶν ἰδιωτικῶν πάντα τὸ προσῆκον ἄνθος ἔσχε, "Indeed, a few years before this the Athenians had received an oracle from Dodona bidding them 'guard the summits of Artemis,' that strangers might not seize them; and now, during the days of the festival, when the fillets with which they entwine the mystic chests were dyed, instead of purple they showed a sallow and deathly colour, and, what was more significant still, all the articles for common use which were dyed along with the fillets took the natural hue." This is reminiscent of the description of dyeing in Egypt in Pliny (1st century AD): *Nat.* 35, 150, xlii.

γέλγει

Another verb signifying to dye is γέλγει, whose etymology is unknown.[20] The Byzantine lexicographer Hesychius (*c.* 5th–6th century AD) glossed it as 'dips, tinges, dyes', and the subsequent entry informs us that γέλγη are petty wares, including dyes.[21] The noun γέλγη is not entirely uncommon and was explained by ancient lexicography as an Attic word corresponding to wider Hellenic ῥῶπος 'petty wares',[22] which, interestingly, could also refer to colouration.[23]

δεύειν

Ancient Greek also had δεύειν, 'to make wet',[24] which provided two verbs presumably connected to dyeing: the verbs ἐνδεύειν and δευσοποιεῖν. The etymology is unexplained, but a connection with δύειν 'to dive, enter' as 'to immerse' has been suggested.[25] The earliest attestation of ἐνδεύειν, 'to soak; to dye in', is in Nicander (2nd century AD) who explains how one should soak a piece of textile in βάμμα, a 'dip', likely vinegar, and thus not used of dyeing.[26] Its clearest connection to dyeing is in Hesychius.[27] The verb δευσοποιεῖν is first attested in Origenes (2nd–3rd century AD) where it is used metaphorically of staining,[28] and Alciphron (2nd–3rd century AD) who writes that women "dye" their cheeks with different substances,[29] which once more implies that the distinction between immersion in the dye-bath and the simple application of colour is not rigid. The same holds true of βαφή, which is also attested in the sense of make-up.[30] The metaphorical use of the verb in the sense of staining and colouring should be presumed to derive from an original sense of dyeing. This is clear not only from the testimony of the lexicographer Pollux of Naucratis (2nd century AD), who speaks of δευσοποιία 'dyeing',[31] but also the commonly attested adjective δευσοποιός, 'dyed, steeped in colour, fast'.[32] The later lexicographical tradition moreover glosses δευσοποιός with βαφεύς 'dyer' and according to Moeris this was an Attic term.[33]

δολοῦν

In our context the verb δολοῦν is curious from a semantic point of view. It derives from δόλος 'bait, any trick or device for catching, trick',[34] and its basic meaning is 'to deceive, beguile, ensnare'. It is, however, also succinctly attested in Pollux in the sense of dyeing wool.[35] Following Hugo Blümner,[36] a likely explanation is found in Spartan moral views on dyeing and the artificial enhancement of personal appearance. In a passage from Athenaeus (c. AD 200) we are told that not only were those who make ointments and perfumes banned from Sparta,[37] but also those who dye wool, because they disguise and remove the whiteness of the wool.[38] The wool is therefore, so to say, deceived, or cheated, of its natural colour. This Lacedaemonian moral stance to dyes extended to the dyeing of

20. Beekes 2010, p. 265; cf. Chantraine 1999, p. 214. It is presumably not connected to γέλγις 'garlic'; see Kroonen 2012 for the etymology of γέλγις.
21. Hsch. *s.v.*: γέλγει· βαπτίζει, χρωματίζει; γέλγη· ὁ ῥῶπος καὶ βάμματα. ἄτρακτοι. καὶ κτένες.
22. Moeris (2nd century AD, Γ 19): γέλγη καὶ γελγοπώλης Ἀττικοί, ῥῶπος καὶ ῥωποπώλης Ἕλληνες.
23. ῥῶπος is explained as μεῖγμα χρώματος in the scholion to Porphyrius (3rd century AD), *Abst.* 4.3.
24. Cf. *e.g.* the *Et. Gud. s.v.*: δεύω· τὸ βρέχω.
25. Beekes 2010, p. 320; cf. Chantraine 1999, p. 267.
26. Nic. *Alex.* 414: βάμματι δ'ἐνδεύσαιο καὶ εὖ περὶ κόρσεα πλάσσοις.
27. Hsch. *s.v.*: ἐνδεῦσαι· βάψαι.
28. Origenes, *Cels.* 3.65.
29. Alciphr. 2.8.3. The φῦκος was a lichen (*Rocella tinctoria*) used as a cosmetic; cf. the verb φυκοῦν 'to be rouged', which was in turn borrowed to Latin as *fūcō* 'paint the face, to colour, paint, dye'.
30. Philostratus the Elder (2nd/3rd century AD), *Epist.* 22: χειλέων βαφαί.
31. Poll. 1.49.
32. *E.g.* Pl. *R.* 429e. Cf. Hsch. *s.v.*: δευσοποιόν· τὸ ἔμμονον καὶ μὴ ἐκπλυνόμενον βάμμα.
33. Moeris (Δ 12): δευσοποιοὶ Ἀττικοί, βαφεῖς κοινόν. Cf. Suid. *s.v.*: δευσοποιός· βαφεύς 'dyer'.
34. Beekes 2010, p. 346; cf. Chantraine 1999, p. 292.
35. Poll. 7.170: δολοῦν τὰ ἔρια.
36. Blümner 1869, p. 81; cf. Blümner 1912, p. 227. A similar sentiment is found in Virgil (1st century BC), *G.* 2, 465–6: *alba neque Assyrio fucatur lana veneno, nec casia liquidi corrumpitur usus olivi,* "if their wool's whiteness is not stained with Assyrian dyes or the service of their clear oil is not spoiled with cassia".
37. Many dyestuffs were also used in the preparation of perfumes and ointments.
38. Ath. *Deipn.* 15.34 (686f): ὡς ἀφανίζοντας τὴν λευκότητα τῶν ἐρίων. Cf. Plut. *Apophth. Lac.* 227F-228E (= Lycurgus 15) and 228B (= 18–19), where dyeing is mentioned explicitly.

hair, which was also seen as deceptive and an expression of falsehood.[39] Spartan views of dyeing were nevertheless ambiguous,[40] since soldiers were apparently allowed the use of artificial "cosmetics". The falsehood of dyeing epitomized by the Spartan phrase "treacherous garments and treacherous unguents" (δολερὰ μὲν τὰ εἵματα, δολερὰ δὲ τὰ χρίσματα)[41] may be countered by their perception of red as a manly colour, justified by the fact that it creates fear in the inexperienced and the notion that the colour is useful because it is identical to the one of blood and therefore disguises wounds from the opponent in battle.[42] This is of course equally deceitful, and so it seems that in Sparta all was fair in war, but not in love.

ἕψειν

Another verb used of dyeing is ἕψειν 'to boil, seethe'.[43] Strictly speaking, it refers to boiling, and while not attested in connection with textiles in literary sources, it is used of dyeing hair, and we should therefore presume a semantic extension from the dyeing process, since the concept of boiling does not lend itself easily to human hair, if not in wigs. Pollux, quoting an unidentified comedian, refers to it as a past expression for dyeing, implying it was no longer used in his time,[44] while Hesychius and Photius (9th century AD) more tersely simply gloss it with βάπτειν.[45] It is also attested in papyri, but it is there understood to refer to the boiling of linen.[46] The verb may be attested as early as Mycenaean Greek in connection with wool or textiles,[47] but this interpretation remains problematic, and *e-we-pe-se-so-me-na* has also been argued to derive from ἔπειν, 'to take care of (*i.e.* cloth to be finished)', or ὑφαίνειν 'to weave'.[48]

μηλοῦν

A further verb is μηλοῦν 'to probe', a denominative of μήλη '(chirurgical) probe'.[49] It is also used in the sense 'to dye', and has the notable variant καταμηλοῦν: 'to dye; to plunge wool in the dye bath with a ladle'.[50] Photius adds that καταμηλοῦν refers to when the stirred wool is pressed in the dye bath.[51]

μιαίνειν

The verb μιαίνειν is generally used with the meaning 'to stain, spoil, defile'. However, it is understood to be a technical term for colouring or dyeing in the *Iliad*,[52] where it is used for what is clearly a prestige object, and not defiled.[53] The stem may also be attested for dyed wool fabrics in the Mycenaean adjective *mi-ja-ro* corresponding to alphabetic Greek μιαρός in the sense 'blood-red' or 'dyed'.[54]

μολύνειν

In the same vein, there is the verb μολύνειν: 'to soil, to stain, to defile'.[55] It is, however, also attested in the sense of colouring cloth in the *Septuagint* and in the *Jewish Antiquities* of Josephus (1st century AD). The interpretation is more uncertain in the first two instances, which relate the deceit of the brothers of Joseph who in their attempt to convince their father of his death took his shirt and soaked it

39. Aelian (1st–2nd century AD), *VH* 7.20.

40. This is noteworthy, since according to Pliny the best European purple came from the district of Sparta (Plin. *Nat.* 35, 45, xxvi). A Spartan dyer (ῥογεύς) is attested in an inscription from the 1st century BC; cf. below under the verb ῥέζειν.

41. Cf. Clem. Al. (1st–2nd century AD), *Strom.* 1.10.48.5.

42. Plut. *Mor.* 238F (= *Inst. Lac.* 24).

43. Beekes 2010, p. 492; cf. Chantraine 1999, p. 394.

44. Poll. 2.35: ἐψήσασθαι τὴν κόμην τὸ καταχρῶσαι ἔλεγον.

45. Hsch. *s.v.*: ἔψειν· τὸ τὰς τρίχας βάπτειν; Phot. *s.v.*: ἔψειν· βάπτειν τὰς τρίχας."

46. *P. Tebt*. III, 1.703, 99–104.

47. MY Oe 127: *pa-we-a*$_2$, *e-we-pe-se-so-me-na*, LANA 20.

48. See Del Freo *et al.* 2010, p. 368 (cf. p. 363), for a lucid discussion and overview of interpretations.

49. Beekes 2010, p. 943; cf. Chantraine 1999, p. 694.

50. Poll. 7.169: μηλοῦν (τὰ ἔρια), καὶ καταμηλοῦν τὸ τῷ κυκήθρῳ καταδύειν. Cf. Hsch. *s.v.*: μεμήλωνται· βεβαμμένοι εἰσίν.

51. Phot. *s.v.*: καταμηλῶν· μηλῶσαι καλοῦσιν οἱ ἰατροὶ τὸ μήλην καθεῖναί που· (…) λέγεται δὲ καταμηλοῦν καὶ τὸ βάπτειν ἔρια ὅτ' ἂν πιέζηται κινούμενα.

52. Beekes 2010, p. 950–1; Chantraine 1999, p. 700–701.

53. Hom. *Il.* 141–146.

54. KN Ln 1568. See *DMIC* I, p. 451, for references to various interpretations. Cf. Del Freo *et al.* 2010, p. 364–365.

55. According to Beekes (2010, p. 965), it is a denominative verb from an unattested base form, giving the tentative root (IE?) **mel(h*$_2$*)*- 'dirt', cf. Sanskrit *mála*- 'dirt, defilement'; see also Chantraine 1999, p. 710–711.

in goat's blood;[56] the same event is described by Josephus, who uses the same verb.[57] However, in the next book of the same work, Josephus uses the verb μολύνειν again, in a clear context of dyeing, and the meaning cannot be one of defilement, since we are informed that these dyed products were among the materials Moses used to build the tabernacle.[58] An original sense of colouring would conform to its placement in a postulated group of colour terms in various Indo-European languages.[59]

ῥέζειν

Yet another verb for 'to dye' is ῥέζειν. It is attested as such in the comic poet Epicharmus (5th century BC),[60] and Hesychius informs us that dyestuffs could be designated by ῥέγματα[61], while the *Etymologicum Magnum* (12th century AD) confirms the meaning 'to dye'.[62] The problem is that modern dictionaries posit two verbs: "ῥέζω 1" and "ῥέζω 2", where the first is taken to mean 'to do, make' and the second 'to dye'. The first verb is referred to the root **u̯erǵ-* 'work' and the second to **sreg-* 'paint'.[63] The latter is due to the perceived Indic parallels to ῥέζειν.[64] The match between Old Indic and Greek would seem to indicate at least late Proto-Indo-European dialect status, but the reconstruction with absolute initial **r-* is highly unusual and problematic.[65] Peter Barber states that "it seems pretty unlikely that this represents a specialization of the verb ῥέζω 'do', since within Greek we may compare ῥέγος (Anacr.), ῥῆγος 'blanket, carpet' (Hom.),"[66] but this is complicated by the fact that it may very well originally have designated a dyed carpet or blanket.[67] The problem also deserves attention from a semantic point of view: in order to *make* a colour through dyeing one must *put* the wool or cloth in the dye bath. The specialisation of the verb from the meaning 'to make (a colour)' is thus unproblematic and has parallels in Latin terms such as *inficere* 'to dye'[68] and *sufficere* (*e.g. suffectus* 'dyed'). The root of the Latin terms is of course

56. LXX, *Ge.* 37, 31: λαβόντες δὲ τὸν χιτῶνα τοῦ Ιωσηφ ἔσφαξαν ἔριφον αἰγῶν καὶ ἐμόλυναν τὸν χιτῶνα τῷ αἵματι. The *Vulgata* uses *tingo*: *Tulerunt autem tunicam eius et in sanguinem hedi quem occiderant tinxerunt*.

57. J. *AJ,* 2.3.4: ἔδοξεν αὐτοῖς διασπαράξασιν αἵματι τράγου μολῦναι καὶ τῷ πατρὶ δεῖξαι φέροντας, ὡς ἂν ὑπὸ θηρίων αὐτῷ φανείη διεφθαρμένος.

58. J. *AJ,* 3. 102–3 (6.1): Οἱ δὲ χαίροντες οἷς τε ἑώρων καὶ οἷς ἤκουον τοῦ στρατηγοῦ τῆς κατὰ δύναμιν αὐτῶν σπουδῆς οὐκ ἀπελείποντο, ἀλλ' εἰσέφερον ἄργυρόν τε καὶ χρυσὸν καὶ χαλκὸν ξύλα τε τῆς καλλίστης ὕλης καὶ μηδὲν ὑπὸ τῆς σήψεως παθεῖν δυνάμενα, αἰγείους τε τρίχας καὶ δορὰς προβάτων τὰς μὲν ὑακίνθῳ βεβαμμένας τὰς δὲ φοίνικι: αἱ δὲ πορφύρας ἄνθος, ἕτεραι δὲ λευκὴν παρεῖχον τὴν χρόαν: ἔριά τε τοῖς προειρημένοις ἄνθεσι μεμολυσμένα καὶ λίνου βύσσον λίθους τε τούτοις ἐνδεδεμένους, οὓς χρυσίῳ καθειργνύντες ἄνθρωποι κόσμῳ χρῶνται πολυτελεῖ, θυμιαμάτων τε πλῆθος συνέφερον: ἐκ γὰρ τοιαύτης ὕλης κατεσκεύασε τὴν σκηνήν, "And they, rejoicing alike at what they had seen and at what they had heard from their general, failed not to show all the zeal of which they were capable. They brought their silver and gold and bronze, timber of the finest quality liable to no injury from rot, goats' hair and sheepskins, some dyed blue, others crimson, some displaying the sheen of purple, others of a pure white hue. They brought moreover wool dyed with the self-same colours and fine linen cloth, with precious stones worked into the fabrics, such as men set in gold and use as ornaments of costly price, along with a mass of spices. For of such materials did Moses construct the tabernacle."

59. Cf. Chantraine 1999, p. 711: "Tous ces mots ont été insérés […] dans une famille (?) contenant des adjectifs de couleur comme grec μέλας, μίλτος, lat. *mulleus* 'rougeâtre', lit. *melsvas* 'bleuâtre', etc."

60. Epich. *fr.* 107: ἀλλὰ καὶ ῥέζει τι χρῶμα. Note that this fragment is attested (*s.v.*) in the *Etymologicum Gudianum* (11th century AD).

61. Hsch. *s.v.*: ῥέγματα· τὰ βάμματα.

62. *EM s.v.*: ῥῆγος· τὸ πορφυροῦν περιβόλαιον· ῥέξαι γὰρ τὸ βάψαι. The *EM* also features further fragments with attestations of words from the same root which concern dyeing: Anacreon (6th century BC), *fr.* 102: ἁλιπόρφυρον ῥέγος; Ibycus (6th century BC), *fr.* 10b: ποικίλα ῥέγματα. There are also several terms for 'dyer', not only ῥεγεύς, but also a Laconian term for 'dyer': ῥογεύς (*IG* V,1, 209, 27: Δάμιππος Ἀγαθοκλέος ῥογεύς); cf. also *Et. Gud.*: καὶ ῥηγεῖς ἔλεγον τοὺς βαφεῖς οἱ παλαιοί. A gloss in Hesychius moreover clearly confirms the semantic extension to embroidery (*s.v.*): χρυσοραγές· χρυσοβαφές ('gold-embroidered').

63. Beekes 2010, p. 1279; Chantraine 1999, p. 969.

64. *I.a.* Sanskrit *rájyati* 'to colour oneself, get red, get excited'; *raktá-* 'coloured, red', *rájaka-* (m.) 'launderer, dyer'; *rāga-* (m.) 'pigment, dyeing'. Cf. Beekes 2010, p. 1279; see further Mayrhofer 1996, p. 424–425.

65. Adams & Barber 1997, p. 572–573. See Barber 2013, p. 356–357, for problems with this reconstruction and the Indo-Iranian evidence. Interestingly, Albanian *regj* 'to tan' has been explained as related to ῥέζω 1 and 2 by respectively Mann (1950, p. 382-383) and Çabej (1986, p. 73-74), cf. Orel 1998, p. 367. See below for the pertinence of tanning.

66. Barber 2013, p. 356. For the lack of a satisfactory explanation of the long vowel in ῥῆγος, one could compare γῆρας 'gift of honour'; originally 'old age' and γέρας 'old age', both from **ǵerh₂-*; cf. Beekes 2010, p. 271; p. 267–268.

67. Cf. the *Et. Orion.*: ῥῆγος· τὸ βαπτὸν στρῶμα.

68. Cf. also the nouns *infectores* 'dyers', *infectus* (*-ūs*): 'the action of dyeing'; Plin. *Nat.* 8.193: *de reliquarum* (*sc. lanarum*) *infectu suis locis dicemus*.

fak-* (*i.e.* giving *facere* 'to do, make') and it is of interest that the Latin verb forms derive from PIEd^{h}eh$_{1}$-* 'to put (away), lay (down), fix, make, create', with cognate verb forms in *i.a.* Greek, which mean 'to put, place'.[69] Further examples may be found in the related domain of tanning, which also consists in placing and submerging the material to be treated in a chemical bath. The same root is found in terms for tanning in Latin,[70] and, moreover, Proto-Germanic **garwjan-* 'to prepare, make ready' provided a number of words in Germanic languages for not only 'to do, to prepare', but also 'to tan';[71] furthermore, also **taujan-* 'to do, make', later acquired the meaning 'to tan' and 'to make, prepare leather'.[72]

τέγγειν

A further verb τέγγειν, from the root **teng-* 'wet, moisten',[73] is first attested in an exhortation to drink in Alcaeus (born *c.* 625-620 BC), although the idiom does not lend itself easily to English.[74] However, the verb is also used in other authors, and in his fourth Olympic ode Pindar (5th century BC) writes, as it is usually understood, that he will not "stain" (τέγξω) his speech by lying.[75] If this widely accepted interpretation of τέγξω is correct, we here have a dyeing metaphor, and we must assume a semantic shift from 'to wet' > 'to dye' and thence to the moral connotation of 'to stain', thereby implying that the verb's sense 'to dye' must predate Pindar. However, a scholiast to the Pindaric passage also suggests a different interpretation, that the verb could mean 'to soften', and thereby 'to make weak', since wetness imparts weakness.[76] The sense of the verb would then be that Pindar will not make his account *weak* through lying, equally plausible, and unproblematic. The verb τέγγειν does not, as far as I have been able to assess, appear elsewhere in the literature in the sense of dyeing. A possible exception is in Aeschylus (525-456 BC), who in connection with the death of a Persian commander writes that when he died he: πυρρσὴν ζαπληθῆ δάσκιον γενειάδα | ἔτεγγ' ἀμείβων χρῶτα πορφυρέᾳ βαφῇ, translated in the Loeb edition by "dyed his red thick and bushy beard, changing its colour in a purple bath (*i.e.* blood)".[77] However, the translation 'to dye', while it does lend itself easily to us, is not strictly speaking necessary: the verb could here merely mean 'to wet, moisten'. Of other Indo-European cognates, the Germanic inherited terms exclusively preserve the sense 'to wet': Old High German *thunkōn*, *dunkōn* 'to immerse', Swiss German *tink* 'wet', Modern High German *Tunke* 'sauce'; only Latin *tingere* 'to wet, imbue' also has the meaning 'to dye'.[78]

φαρμάσσειν

The verb φαρμάσσειν: 'to treat with φάρμακα, to heal, poison, enchant', but also 'to dye', derives from φάρμακον 'healing or harmful medicine, healing or poisonous herb, drug, poisonous potion, magic (potion), dye, raw material for physical or chemical processing'.[79] Both Schwyzer,[80] Chantraine,[81] and Beekes[82] advocate a non-Greek origin of the root, although Chantraine later allowed for a possible Indo-European interpretation, but concluded by stating that "En définitive, la question de l'origine de φάρμακον est insoluble en l'état présent de nos connaissances".[83] The root is generally presumed to be attested also in Mycenaean Greek, but in an unclear context;[84] of course, materials

69. Beekes 2010, p. 1482–1483; de Vaan 2008, p. 198–199; Chantraine 1999, p. 1117.

70. Cf. *e.g.* Plin. *Nat.* 24.56.94: *rubiam, qua tinguntur lanae pellesque perficiuntur.*

71. Notably German *gerben* 'to tan, to prepare', 'to finish, make'; see Kroonen 2013, p. 170; Kluge & Seebold 2011, p. 350: "Im Verlauf der mittelhochdeutschen Zeit wird das Verb eingeengt auf 'Leder fertigmachen, gerben'".

72. Cf. Middle Low German 'to tan'; Middle Dutch 'to make, prepare (especially leather)'; Kroonen 2013, p. 511.

73. Beekes 2010, p. 1457; cf. Chantraine 1999, p. 1098.

74. Alc. 347a: τέγγε πλεύμονας οἴνωι.

75. Pi. *O.* 4.17: οὐ ψεύδεϊ τέγξω λόγον.

76. *Schol.* 28d: (οὐ ψεύδει τέγξω·) οὐ ποιήσω τὸν λόγον ἀσθενέστερον, ἀπὸ μεταφορᾶς τῶν βρεχομένων· ταῦτα γὰρ ἀσθενέστερα γίνεται.

77. A. *Pers.* 316–17.

78. Beekes 2010, p. 1457; cf. de Vaan 2008, p. 620.

79. Beekes 2010, p. 1554.

80. Schwyzer 1968, p. 497: "fremd".

81. Chantraine 1933, p. 384: "φάρμακον 'breuvage magique' et φαρμακός 'magicien' (…) est un terme religieux probablement emprunté".

82. Beekes 2010, p. 1554; cf. Beekes 2014, p. 65–66.

83. Chantraine 1999, p. 1179.

84. PY Un 1314.1: *pa-ma-ko*, cf. *DMIC* II, p. 77: "Se admite en general la interpr. φάρμακον 'droga medicinal', pero el contexto es sumamente ambiguo".

for dyeing are often unclear in ancient sources, since their use extends to food, medicine, cosmetics and perfumes, as well as cult, ritual and magic. The verb is, however, securely attested in the sense of dyeing: Pollux states that it is also used in the sense 'to dye wool',[85] and that the term φαρμακῶνες, 'dye-houses', was found in Sophocles.[86] Furthermore, according to Hesychius dyestuffs could also be termed φάρμακα.[87]

Verbs related to χρῶμα

The basic ancient Greek word for 'colour' is χρῶμα, connected to χρόα 'surface of the body, skin, skin-colour, colour'.[88] Multiple candidates for dyeing verbs derive from the root; notably χρώζειν 'to colour, dye, stain',[89] and χρωννύναι, as well as καταχρωννύναι, used for the dyeing of hair and textiles.[90] The root may be attested already in Mycenaean in the so-called *ko-ro-to* tablets recording wool.[91] The adjective *ko-ro-to* would then refer to wool dyed in a dye bath, as opposed to another Mycenaean term, *ki-ri-ta*, which would designate the simple application of colour to cloth.[92]

Dyeing individual colours

There is also a range of verbs for dyeing specific colours. These are unsurprisingly mostly denominative verbs and there is a clear terminological distinction between the material used for dyeing and the resulting colour itself. The ones characterised by the material are ἀληθίζειν, 'to dye with true purple' (cf. the adjective ἀληθινοπόρφυρος 'of true purple');[93] ἐρυθροδανοῦν, 'to dye red' (*i.e.* with ἐρυθρόδανον, 'madder');[94] καλχαίνειν, 'to dye purple' (with κάλχη 'murex'), κογχίζειν, 'to dye purple' (κόγχη 'mussel', *i.e.* murex); as well as πορφυρευθῆναι, 'to be dyed with purple'. The second group is terminologically characterised by the colour obtained through the dyeing process: γλαυκοῦν, 'to dye blue-grey'; ἐρυθαίνειν, 'to dye red'; ἐρυθραίνειν, 'to make red, paint or dye with red'; καταφοινίσσειν, 'to dye red'; ξανθοῦν, 'to dye yellow'; πορφύρειν, 'to make purple, dye red'. The latter verbs highlight the problem of whether the verb derives from the colour purple itself, or from the murex used to obtain it. There are moreover numerous other words connected to dyeing specific colours, *e.g.* ὑακινθινοβαφής 'dyed with hyacinth' or κροκόβαπτος 'saffron-dyed'.[95]

Concluding observations

The large number of synonyms or near-doublets of verbs for dyeing in ancient Greek conforms to the statement of Elizabeth Barber that this phenomenon is the "most striking and productive aspect of the Greek textile vocabulary".[96] This is further confirmed by the impressive number of generic terms for colourants in ancient Greek: χρώματα: 'colours, dyes', unexplained etymology; ἄνθη 'flowers, dyes', presumably from the IE root *h_2end^h- 'sprout'; βάμματα 'dyes', from βάπτειν 'to immerse (in order to dye)', disputed etymology; φάρμακα, presumably of non-Greek origin; ῥέγματα, from ῥέζειν 'to dye', problematic etymology; γέλγη, 'dyes', no etymology. The fact that their etymologies are uncertain and problematic is probably due to the fact

85. Poll. 7.169: λέγεται καὶ φαρμάττειν τὰ ἔρια. Cf. Eust. (12th century AD), *Comm. ad Hom. Il.* 4,648: ἐπεὶ καὶ φαρμακῶνες τὰ βαφεῖα ἐκαλοῦντο, καὶ φαρμάσσειν τὸ βάπτειν ἐλέγετο παρὰ τοῖς παλαιοῖς.

86. S. *fr*. 1109 (Radt): φαρμακῶνες, 'dye-houses' (= Poll. 7.169).

87. Hsch. *s.v.*: φαρμακῶνες· τὰ βαφεῖα, διὰ τὸ τὰ βάμματα φάρμακα καλεῖσθαι.

88. Beekes 2010, p. 1650–1651; Chantraine 1999, p. 1279. The etymology is unexplained.

89. *E.g.* Alexis (4th century BC) *fr*. 141.9: τὸ καλὸν δὲ χρῶμα δευσοποιῷ χρῴζομεν. Cf. also χροάζω 'to colour'; χρωματίζω 'to colour, tinge, dye'; χρωτίζω 'to colour, dye'.

90. Poll. 7.169: χρωννύς, καταχρωννύς, 'dyed'; Poll. 2.35: καταχρῶσαι τὴν κόμην, 'to dye the hair'.

91. See Nosch 2007, p. 54–55.

92. Cf. Del Freo *et al.* 2010, p. 368: "E. Luján has argued that the word *ki-ri-ta/k^{h}rista*/(cf. χρίω, "to rub", "to anoint") attested on KN Ld 785.1, may have designated a technical process in which the colour was applied onto the cloth, as opposed to *ko-ro-to* / *khrōston*/ (cf. χρώζω, "to dye") (KN Od 485, 486, 487, MY Oe 106), which would have implied the immersion of wool/cloth into a dye bath. However, he also indicates that it cannot be entirely excluded that the difference might be explained by a personal preference of the scribe, thus not necessarily corresponding to a technical difference" (referring to Luján 1996–1997, p. 351).

93. See Bogensperger 2017, p. 237–239 and Martelli 2014, p. 121–126, for discussions of true and false purple.

94. Cf. also Suid. *s.v.*: ἠρυθροδανωμένον · ἐρυθρῷ βάμματι βεβαμμένον.

95. Cf. the κρόκου βαφάς in Aesch. *Ag.* 239; the precise colours designated by the many ancient Greek colour words are notoriously problematic and difficult to identify; see *e.g.* Edgeworth 1988 for a thought-provoking discussion of the 'saffron'-coloured terms in Aeschylus.

96. Barber 1991, p. 276.

that dyestuffs were often imported items of trade, whose terminology is likely to provide loanwords.[97]

The terminological characteristics are also interesting from a practical perspective.[98] None of the words unfortunately seem to distinguish terminologically between substantive and adjective dyeing, but several terms derive from specific stages in the dyeing process. The immersion of the cloth or fibres in the dye bath could be denoted by βάπτειν, and presumably also ἐνδεύειν, and δευσοποιεῖν. The verb ἕψειν refers to the boiling of the fibres in the dyestuffs, while μηλοῦν and καταμηλοῦν seem to originally have referred to the submersion and plunging of wool in the dyebath with a ladle. Only one term – παραβάπτειν 'to dye at the same time and obtain different colours' – suggests the use of mordanting, but its rarity and context suggests that it should not be understood as a technical term. Additionally, a large group of terms is built on the generic root for the material of the dyestuff itself: φάρμακα, ἄνθη, and γέλγη. The verb ἀληθίζειν, attested in Egypt where there was a plethora of substitutes for genuine purple, obliquely refers to dyeing with 'true' purple: the murex dye (ἀληθινοπόρφυρος); it could also be designated by πορφυρευθῆναι, καλχαίνειν, and κογχίζειν (all related to murex terms). There is furthermore the verb ἐρυθροδανοῦν which was used of dyeing with madder (ἐρυθρόδανον). Finally, and as is to be expected, many verbs simply refer to the colours obtained through the process of dyeing: γλαυκοῦν; ἐρυθραίνειν; ξανθοῦν; in addition to καταφοινίσσειν and πορφύρειν, although these may equally refer to the dyestuff.

From a semantic point of view, it is interesting that some terms for dyeing are heavily marked by ethical connotations and connected to the moral sphere. As in English, as well as other languages, defilement is connected to staining and thus also to dyeing: μιαίνειν seems to have evolved semantically from 'to dye' > 'to stain', while the meaning of μολύνειν conversely may have been extended from 'to stain' > 'to dye'.[99] In addition, dyeing may also be expressed pejoratively by a verb originally meaning 'to disguise, deceive, mask' because it removes the inherent colour of wool (δολοῦν), but this expression seems limited to a peculiar Spartan context and ethos. A further semantic feature shared by several dye terms concerns their use to designate decoration, especially embroidery.[100]

Some terms also exhibit Ancient Greek dialectal differentiation: δευσοποιός is stated to have been an Attic term corresponding to common Greek βαφεύς 'dyer', while the noun γέλγη was an Attic term corresponding to Hellenic ῥῶπος. Moreover, the problematic verb ῥέζειν has a number of variants in various dialects (ῥεγ-, ῥαγ-, ῥηγ-, ῥογ-) which compound the difficulties of its etymological interpretation.

Ancient Greek thus had a rich terminology for dyeing and the terms are important not only *per se*, but also from a technical perspective since they shed light on practical dimensions of dyeing and complement more or less obscure passages in other sources. The ancient lexicographers are a crucial source in this regard, since they preserved fragments of authors otherwise lost, but also because they provide explanations for dyeing terms that were unusual or noteworthy in some way and attest to the terminological complexity of the craft of dyeing in the ancient world.

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97. A comprehensive study of Indo-European and further Eurasian terms for dyeing and dyestuffs (a number of which were also used as *i.a.* spices and medicine) and their transmission would shed valuable light on ancient trade.

98. Cf. Koren 2015 for the proficiency and skill of ancient dyers as evident in the modern chemistry of ancient dyeing.

99. One may compare with ἀποχραίνω: 'to grade or tinge colours' *versus* χραίνω 'to besmear, sully, stain'; cf. Beekes 2010, p. 1646.

100. In addition to ἀνθίζειν one may add, on account of the material, the clear evidence for this semantic extension in connection to gold embroidery: χρυσοραγές (cf. ῥέζειν) and χρυσοβαφές (cf. βάπτειν).

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Dyeing in texts and textiles: words expressing ancient technology

Ines Bogensperger & Helga Rösel-Mautendorfer

Introduction

The complex *chaîne opératoire* of ancient textile production in various stages has been frequently discussed by textile scholars.[1] According to documentary papyri, textile manufacturing represented the highest taxed industry after agriculture. This emphasises its importance as a significant sector in the ancient economy. A highly specialised branch within the *chaîne opératoire* is the dyeing industry. Ancient dyers used natural and animal dyestuffs, as well as different dyeing techniques to achieve their colourful results.[2] They were also aware of the specific properties of the different textile fibres. In ancient times, wool and linen were the characteristic materials for manufacturing textiles, but archaeological and papyrological sources further attest the use of cotton, silk and even goat hair.[3] Depending on the particular fibre properties and the natural pigmentation, different results, colours and hues could be achieved. Preserved textiles show that mainly wool was dyed, but there are dyed linen textiles as well.[4]

The present paper aims to examine the outstanding mastery, skills and practical knowledge that are seen in both Greek documentary papyri and preserved late antique textiles.[5] We also would like to point out an indicative *modus operandi* to determine ancient technology.

Textual evidence[6]

Greek documentary papyri

The vast corpus of Greek documentary papyri offers us valuable insight into the ancient dyeing industry and specific economic activities that are impossible to assess from the preserved objects. In the texts, garments and other fabrics are usually described by their colours. Several studies have examined words for colours and their meaning in literary and documentary sources.[7] The Greek terms either evoke a particular dyestuff or use a comparative image to describe the colour. In particular, the purple obtained from mollusc species has often been examined by scholars. Being a rare

Published in Maria Mossakowska-Gaubert, ed., *Egyptian Textiles and Their Production: 'Word' and 'Object' (Hellenistic, Roman and Byzantine Periods)* (Lincoln, NE: Zea Books, 2020). doi 10.32873/unl.dc.zea.1086

1. For example, Andersson Strand 2012.
2. Schweppe 1993; Hofenk de Graaff & Roelofs 2004; Cardon 2007.
3. For example, Wild 1970, p. 4–21; Bagnall 2008; Rast-Eicher 2016, p. 74, 88, 252, 262 and 282–283.
4. In literature, one can occasionally read that linen was difficult to dye, a statement which is *per se* not correct. The treatment and the obtained results differ from wool, silk or cotton. On the topic of dyeing linen in Pharaonic Egypt, see Goyon 1996.
5. This paper is a result of the research project "Texts and Textiles from Late Antique Egypt", funded by the Austrian Science Fund, FWF-P 28282. We are thankful to all our friends and colleagues for their support, especially, Regina Hofmann-de Keijzer, Mathijs de Keijzer, Maarten R. van Bommel, Helmut Eberhart, Ineke Joosten, Georg Rösel, Mark Clarke, Bernhard Palme, Peter Bichler, Ingrid Balka, and Joseph Koo. We are grateful to Hildegard Kirchweger, who corrected our English.
6. For lexicographical studies of Greek terminology for the action of textile dyeing, see the article by Peder Flemestad, in this volume (Flemestad 2020).
7. For example, Reiter 1962; Warp 1997; Andorlini 1998; Froschauer 2007.

Figure 1. Yarns consisting of blue and red dyed fibres used for a tapestry: *P. Vindob*. Stoff 270, Papyrussammlung, Austrian National Library. (Photo: Maarten R. van Bommel © Austrian National Library, Vienna).

and precious colour, it has a certain attraction, which can be also observed for insect dyes. The majority of analysed textiles, however, show the use of plant dyestuffs, often a combination of blue and red.[8] This was used not only in overdyeing, but also in spinning blue- and red-dyed fibres to obtain purple (fig. 1). Only a few papyrus documents suggest the use of mollusc dyestuff.[9] This corresponds well to the general picture we get from the dyestuff analyses, that is to say, mollusc purple was still used in late antiquity but only for a few textiles.

Amongst the numerous colour terms, βλάττα is a prominent example. Initially, it denotes mollusc purple and in this sense it is found in the legal sources Codex Theodosius (Cod. Theod. 10.20.13; 10.20.18) and Codex Iustinianus (Cod. Iust. 10.21.3; N 40.1). However, some words change their meaning over time. Rodolphe Guilland states that in the 10th century *Book of Ceremonies*, *blattion* denotes rather silken textiles regardless of their colour.[10]

Papyrus texts demonstrate that not only were various dyeing materials distinguished but also different grades of a particular dyestuff. In the declaration of prices by a guild, *P. Oxy*. LIV 3765 (c. AD 327), we encounter two categories of quality for the same dyestuff: κοκκίνου α λί(τρας) α τάλ(αντα) η | β κοκκίνου λί(τρας) α τάλ(αντα) β (ll. 19-20). The text records one pound of kermes of first grade quality (α) for eight talents, while one pound of kermes of second

8. Already noted by the French chemist, Rodolphe Pfister (Pfister 1937, p. 12).

9. See Worp 1997; Bogensperger 2017.

10. Guilland 1949, p. 333–348; recently Morelli 2017, p. 133 n. 14.

grade (β) is priced at two talents.[11] Harald Froschauer suggests that the difference results from different insect species.[12] It might further be possible that the processing of the insects had a significant impact on the quality and hence the price of the commodity. A comparable situation can be observed for the American cochineal from Mexico.[13] At any rate, it is plausible that dyestuffs were priced also by quality, which illustrates not only the production and supply chain of dyestuffs but also the professional knowledge of ancient dyers, who had to select their materials carefully.

Documentary papyrus texts give us some clues as to the economic environment. We encounter the occupation βαφεύς (*bapheus*), the dyer, in various contracts, which illustrates their active role in ancient business life. *Baphoi* are widely attested in papyrological and epigraphical documents. Even a female dyer, βάφισσα, is mentioned in two papyri: *P. Oxy.* XXIV 2421, 47 (AD 312-323)[14] and *O. Petr. Mus*. 449, 1-2 = *SB* I 1957, 1-2 (4th century AD). Kai Ruffing notes in his comprehensive study that the *collegia* of dyers are known from Imperial Roman inscriptions.[15]

Renate Germer investigated texts from Pharaonic times and she identifies *pś jnś* (literally "boiler of linen") as "dyer" in five texts from the New Kingdom and in one from the time of Hadrian.[16] This meaning, however, seems to be questionable, especially as we find the professional occupation of λινεψός and λινοπλυτής ("linen-boiler") in Greek documentary papyri. The activity is more probably connected with the processing of linen, including bleaching.[17] According to Ewa Wipszycka, *linoplytes* replaced the Ptolemaic *linepsos* in the Roman era.[18]

Apart from the craftsman, we learn of dyeing workshops, *bapheia,* for which leasing contracts were agreed: *P. Osl.* III 139 is possibly an example from the 2nd century AD, however, the text is too fragmentary to provide further information. The 6th century contract *CPR* XIV 10, 13 explicitly names its purpose as μί]σθ(ωσις) ἐ̣ργαστηρ(ίου) βαφ(ευτικοῦ) on its *verso*. The dye workshop was leased by brothers presumably from Flavius Apion II, a large estate owner.[19] *P. Ross.Georg*. III 38, also dated to the 6th century, shows that a former general store is leased as a dyer's workshop. The place is located in a private house, next to the southern *agora* of Antinoopolis, a public market place of the city.[20]

The dyeing industry and all its craftsmen depended on a complex supply chain providing them with various materials and ingredients. In particular, additives, *i.e.* additional substances needed for dyeing, were traded over distances. Mordant salts such as alum, στυπτηρία, were essential ingredients. Alum was the main mordant, as we see in dyeing recipes, which was mined in the oases of Egypt's Western Desert. Its mining, transport and trade were carefully regulated in a state-controlled monopoly.[21]

In addition, papyrus texts reveal particular means of communication to express a desired hue, which is better known from later times. Clients and dyers used colour patterns, small samples of dyed wool, to specify the hue. Samples also served as references for the purchase of wool of a particular colour: in Roman literature we find the Latin term *exemplum* (cf. *Rhet. Her*. 4.5.9). In brief, the available evidence illustrates that ancient dyers did not produce their results randomly, but according to the customer's specific idea and concept. Samples and patterns, such as weaving cartoons, served as reproducible models.

To date, several known papyrus texts mention samples for ordering textiles, *e.g.*: *BGU* IV 1141, 40-43; *P. Oxy.* LV 3806, 7-13; *P. Oxy.* VIII 1153, 18-25; *P. Giss.Apoll.* 11, 14-16 (= *P. Giss.* I 20, 14-16 = *W. Chr.* 94, 14-16); *P. Oxy.* I 113, 4-9.[22] The term δεῖγμα is often used, sometimes as a compound, and it is found as a loan word in the Coptic business letter *P. Kellis* VII 58, 15-20.[23] Moreover, we find paraphrases or collocations that refer to a small amount of dyed wool.

11. On the use of δευτέριος and πρωτεῖος to denote quality in papyri, see Reinard 2017, esp. p. 209–214.
12. Froschauer 2007, p. 707.
13. Cardon 2007, p. 623; Roquero 2006, p. 143.
14. On the date, cf. BL VIII, p. 257.
15. A compilation of the papyrological evidence is provided by Ruffing 2008, p. 453–459.
16. Germer 1992, p. 134–135.
17. Ruffing 2008, p. 640–641.
18. Wipszycka 1965, p. 23.
19. Kovarik 2012, p. 111–112; regarding the discussion on the location, cf. BL X, p. 54.
20. Andorlini 1998, p. 158.
21. Kruse 2007; Bogensperger 2017.
22. On ordering textiles, see Bogensperger 2016, see also the article by Aikaterini Koroli, in this volume (Koroli 2020); on the general topic of patterns and samples in Greek papyrus texts, see Bogensperger & Koroli in prep.
23. We are grateful to Jennifer Cromwell for discussions regarding this term.

The private letter *P. Oxy.* LV 3806, 7-13 (21 May, AD 15) perfectly illustrates the customer's expectations:

τὸ δῖγμα (l. δεῖγμα) τοῦ | [ἐ]ριδίου δῖξον (l. δεῖξον) Φιλοῦτι καὶ γράψον μοι ἢ (l. εἰ) ἀρέσ|κει αὐτῆι ἢ οὔ. πείθομαι δὲ μᾶλλον ἀρέσσειν (l. ἀρέσειν). | πᾶσαν γὰρ ἐργασίαν ἔδωκα ἐκτὸς τοῦ καὶ ξενικὸν | δεῖγμα δεδωκέναι τῶι βαφεῖ, καὶ ὅμως κάλλιον | τοῦτο ἐξέβηι (l. ἐξέβη).

"Show the sample of wool to Philūs, and write me if it pleases her or not. I believe that it will rather please her, for I gave (it) every attention, besides having given the dyer an imported sample as well and even so this one turned out nicer".[24]

The evidence of colour samples has a significant impact on our understanding of how materials were chosen and ordered, and what expectations ancient dyers had to fulfil. To dye according to a specific colour sample with natural dyestuffs demonstrates the extraordinarily high skill level and expertise of ancient dyers, as we will demonstrate below in our dyeing experiments.

Ancient dyeing recipes

In addition to the evidence from documentary papyri, we find technical instructions, recipes, providing us not only with information that certain dyestuffs and materials were used, but also how and in what form.[25] Following Conrad Leemans' publication of *Papyrus Leidensis* (*P. Leid.*), of which Papyrus no. X is particularly interesting for our study, Otto Lagercrantz named a closely related source as *Papyrus Graecus Holmiensis* (*P. Holm.*).[26] Both papyri are categorised as so-called subliterary, or sometimes as paraliterary texts, a group that refers not to literary texts *per se* and also differs from documentary texts. *P. Leid.* and presumably also *P. Holm.* are said to have been found in Thebes.[27] They are dated to the 3rd–4th century AD.[28] Otto Lagercrantz emphasised the close connection between the two papyri, which he even calls "twins".[29]

Both were codices, however, they are preserved as separate papyrus sheets today. According to the first editor O. Lagercrantz, *P. Holm.* is almost entirely preserved with the exception of some missing pages from the cover.[30] The text of both *P. Holm.* and *P. Leid.* X was written in uncials script.

In both codices, recipes are compiled on various topics dealing with metallurgy, how to make alloys, producing gemstones, colouring various materials, and dyeing textiles. Several recipes have titles, but there is no general heading to the codex.

The recipes reflect what might best be summarised as ancient alchemical knowledge. Marcelin Berthelot argues that it is a "science qui avait pour but la fabrication et la falsification des matières d'or et d'argent".[31] This statement sparked debates and theories that these were the texts of forgers. The chemist Karl Reinking finally refuted this suspicion,[32] and the ancient recipes were gradually considered to be for practical dyeing experiments.[33]

Examining *P. Holm.* and *P. Leid.* X, one wonders to whom they were addressed. Without being able to provide a definitive answer, we have gathered some preliminary arguments regarding the readership.

M. Berthelot, mentioned above, observes the work of a craftsman but he evokes the image of "charlatanisme".[34] He writes of an "artisan faussaire", who is interested in chemistry and magic.[35] The chemist K. Reinking argues that these recipes address the craftsman, the dyer. O. Lagercrantz cannot deny a certain degree of expertise and even the work of several generations in the knowhow of these recipes. He points out that the knowledge contained is not an invention, but a compilation of older sources.[36]

24. English translation, *ed. pr.,* p. 176.
25. For a general overview on historic recipes, see Clarke 2013; Kirby *et al.* 2014, p. 35–48; Martelli 2014.
26. The papyrus with ancient recipes is labeled as 'X', therefore *P. Leid.* X; see Leemans 1885, p. 199–259.
27. Leemanns 1885, p. 199: "*Papyrus Thebis inventus* …"; Lagercrantz 1913, p. 45–47.
28. Leemans 1885, p. 199: "*… saeculo III° exeunte aut IV° ineunte…*"; late 3rd century: Berthelot 1887, p. 22; Lagercrantz 1913, p. 53–54: not older than 4th century; Halleux 1981, p. 22–24: time of Constantine; Kreuzner 2013, p. 124: late 3rd – early 4th century.
29. Lagercrantz 1913, p. 47–50.
30. *Ibid.*, p. 51.
31. Berthelot 1887, p. 19–20.
32. Reinking 1938, p. IV.
33. See, for example, Martínez Garcia 2016.
34. Berthelot 1887, p. 22.
35. *Ibid.*, p. 5.
36. Lagercrantz 1913, p. 69–70.

To date, scholars agree that *P. Holm.* and *P. Leid.* are copies of a lost oeuvre of ancient alchemy. Both papyri are not the originals but were used as manuscripts by private "non-professional" persons. The uncials point to a broader audience.[37] Following O. Lagercrantz, we conclude for the time being that the form of a codex, the palaeography and the content show at least some kind of publication addressing a readership with specialist knowledge in the field.

Dyeing technology in the ancient recipes

Inspired by the specialised knowledge attested in both documentary papyri and ancient dyeing recipes, we aim to seek a new approach through experimental archaeology. In modern dyeing recipes, a single main dyestuff is used, whereas in the ancient dyeing recipes, *P. Holm.* and *P. Leid.* X, various additives, an additional dyestuff or inorganic substances are combined, such as sodium carbonate (νίτρον: *e.g.*, *P. Holm.* 94, 632; *P. Holm.* 108, 753),[38] metals, *i.e.* iron dross (σκωρία σιδήρου: *e.g.*, *P. Holm.* 98, 661, *P. Leid.* X 99, 576), organic substances, such as blood (αἷμα: *e.g.*, *P. Holm.* 156, 1098-1099: "pig's blood"), vinegar (ὄξος: *e.g.*, *P. Holm.* 91, 620; *P. Holm.* 96, 645; *P. Leid.* X 94, 524), and pulses (λεκίθιον "bean-meal": *e.g.*, *P. Holm.* 112, 823 and θέρμος "lupine": *P. Holm.* 159, 1118: *P. Holm.* 118, 877).

The ancient recipes explicitly mention the use of different qualities of water, such as salt water (θάλασσα: *e.g.*, *P. Holm.* 102, 700), drinking water (ὕδωρ πότιμον: *e.g.*, *P. Holm.* 113, 836), rainwater (ὄμβριον ὕδωρ: *e.g.*, *P. Holm.* 114, 853), and water from a coppersmith (χαλκέως ὕδωρ: *P. Holm.* 118, 881). There are several indications of the duration (*e.g.*, *P. Holm.* 96, 645 "overnight"; *P. Holm.* 105, 719 "for three days") and the temperature of the dye, such as boiling and cooling down (*e.g.*, *P. Holm.* 101, 695), hot dyeing (*e.g.*, *P. Holm.* 112, 820), and cold dyeing (*e.g.*, *P. Holm.* 106, 727; *P. Holm.* 121, 899; *P. Holm.* 123, 912). Some recipes recommend an alkaline dye bath by adding ash (σποδός: *e.g.*, *P. Holm.* 112, 816).

Climatic conditions have an influence on the growth of plants and insects that might be decisive for the dye components. Climatic conditions also influence the drying process of the plants, or how long it takes to prepare the

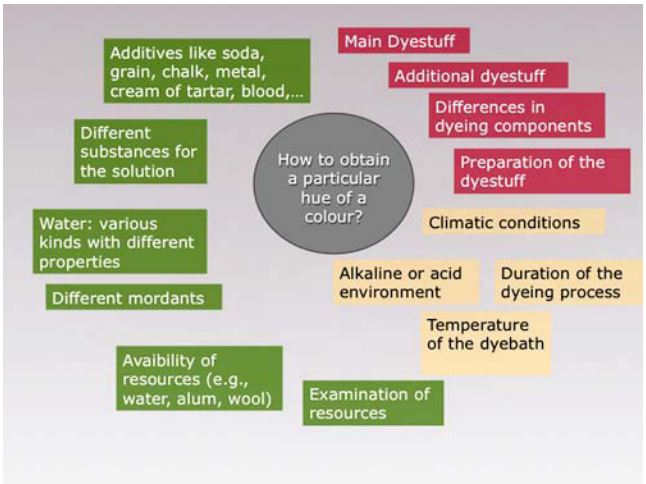

Figure 2. Various factors that influence the dyeing process and the colour. (Design and drawing © Helga Rösel-Mautendorfer & Ines Bogensperger).

fermentation vat. All these parameters affect the hue (fig. 2). Moreover, the combination of various additives with different parameters clearly reflects how ancient knowledge and technology can modify the result, *i.e.* the final colour. At any rate, we get the impression that the dyeing process was more sophisticated than generally assumed and that variations and modifications need to be considered. Thus, thorough planning of the dyeing process was required.

Dyeing experiments

Dyeing experiments are frequently included in textile research. They are performed in laboratories with controlled conditions.[39] Naturally, the material used is "of modern date", in other words, it is almost impossible to get old breeds of sheep and dye plants. Usually, small amounts are dyed in a sterile condition, which differs from the conditions of ancient daily life where large quantities of fibres, yarns, or textiles were necessary for manufacturing textiles. We get some hints from the archaeological evidence of dyeing workshops, for example in Pompeii,[40] as well as from papyrus texts, where the employment contract *CPR* XIX 33 attests the dyeing of fabric (fig. 3):[41]

37. *Ibid.*, p. 88.

38. On *nitron* cf. further Beekes 2010, p. 1022 *s.v.*

39. For example, CHARISMA Project "Natural Colorants for Dyeing and Lake Pigments" (2009–2014); see Kirby *et al.* 2014; FWF research project (L431–G02) "Dyeing techniques of the prehistoric Hallstatt-Textiles: analysis, experiments and inspiration for contemporary application" (2008–2012), see Hartl *et al.* 2015a, b.

40. Flohr 2013, p. 60–62. Lowe 2016, p. 239–244.

41. On the date AD 591, Oct. 19–27, cf. BL XIII, p. 80.

… καὶ βαφικ(οῦ) πανιν̣ιυ (l. παννίου) ἑνὸς ἡ|μίσεως …

"… and 1½ pieces of cloth (*pannus*) suitable for dyeing …"

Experiments in the laboratory are quite useful to understand the dyeing process and to test the different parameters of a recipe. In order to examine how ancient dyers really *worked* in the past, we performed several experiments in a non-sterile environment using ceramic vessels, an open fireplace, or pits filled with water and heated with hot stones.

The textile fragment P. Vindob. Stoff 256

The fragment inventoried as *P. Vindob.* Stoff 256 originates from a burial ground of late antique Egypt and is housed in the Papyrussammlung of the Austrian National Library, Vienna.[42] It is 64.1 cm long and 148.4 cm wide. Wool was used in various colours and yarn diameters. The green ground weave shows a weft-faced tabby. The decoration of the purple-coloured medallions (*orbiculi*) and the stripes (*clavi*, but once *manicae*, cuff bands) is made in tapestry technique, which was woven into the ground fabric. For the elaborate geometric pattern flying thread and soumak were used while the textile was on the loom. All preserved selvedges and borders are decorated with multi-coloured fringes. In its current state, the fragment is badly damaged and shows traces of repairing, mending and reworking. It can, however, be reconstructed as a colourful wool tunic with rich decorations (fig. 4). In comparison with similar artefacts that have been radiocarbon dated, the textile presumably dates from the period after the Arab conquest of Egypt (AD 640/641).

Five samples were selected for dyestuff analysis to determine all colours of the textile: red, green, yellow of the ground weave; purple and light purple of the *clavi*. The analysis was performed with ultra-high performance liquid chromatography coupled with photodiode array detection (UHPLC-PDA) by Maarten R. van Bommel in cooperation with the University of Amsterdam and the Rijksdienst voor het Cultureel Erfgoed. The results refer to the use of woad or indigo, madder types and weld (Table 1).

Due to its large size, it is not possible to display the original textile fragment in the Papyrussammlung, however, a modern reproduction is planned. In order to replicate the colours, we considered not only the results of the UHPLC-PDA analysis but also the colours preserved on the textile. Furthermore, we examined the evidence from papyrus texts, especially the information that ancient dyers were able to reproduce a desired colour hue according to a small sample.

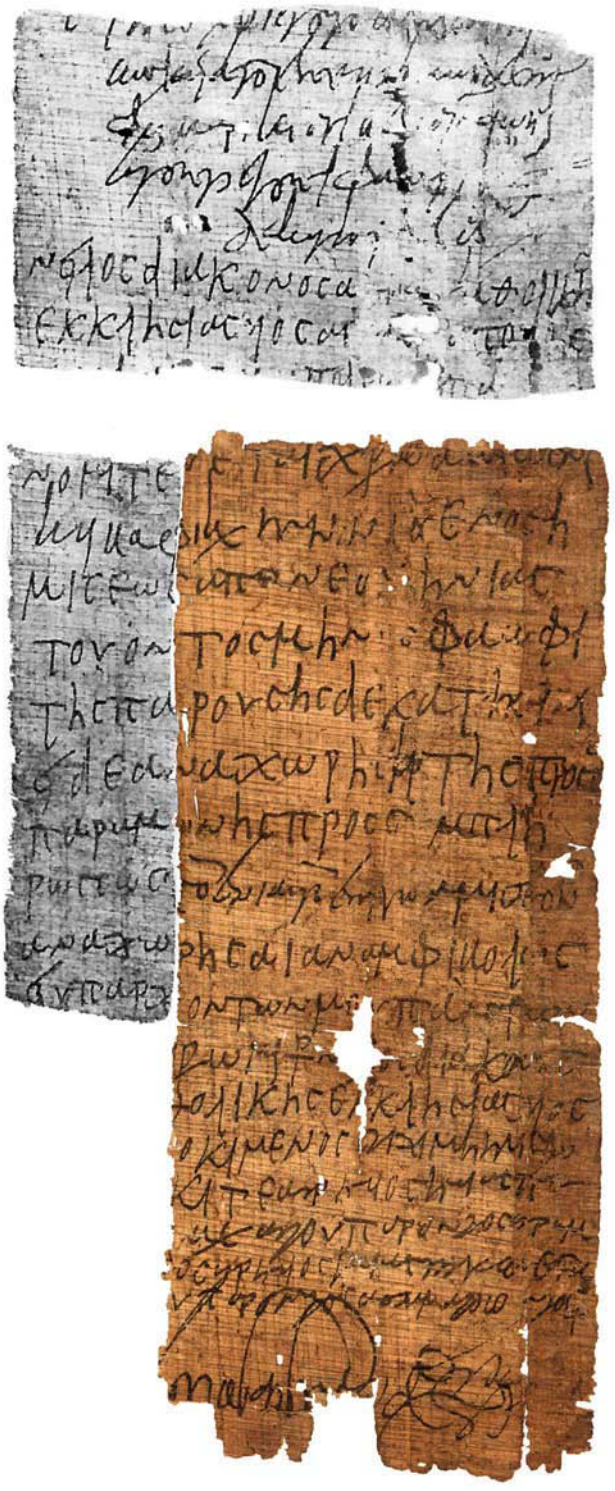

Figure 3. Graphic reconstruction of *CPR* XIX 33: two fragments held in Paris (MN 6846 App. 708 + MN 6846 App. 325), one in Vienna (P. Vindob. G 25648). Reconstruction from photos published in *CPR* XIX. (Reconstruction © Ines Bogensperger).

42. Bogensperger 2014 with comprehensive technical details.

Figure 4. Textile fragment: *P. Vindob.* Stoff 256, Papyrussammlung, Austrian National Library. (Photo © Austrian National Library, Vienna).

Table 1: Summary of the results and the interpretation of the UHPLC-PDA analysis of *P. Vindob.* Stoff 256.[43]

Colour	Sample location	Dyeing components	Dyeing material
Green	ground fabric between *orbiculus* and *clavus*	indigotin, indirubin, isatin	woad (*Isatis tinctoria* L.) or indigo (*Indigofera tinctoria* L.)
		luteolin, apigenin	weld (*Reseda luteola* L.)
Purple	area of the hem of the *clavus*	indigotin, indirubin, isatin	woad (*Isatis tinctoria* L.) or indigo (*Indigofera tinctoria* L.)
		alizarin, purpurin, rubiadin, xanthopurpurin	madder types (*Rubia tinctorum* L. or *Rubiaceae* species)
light purple	bright purple-coloured sleeve band	alizarin, purpurin, rubiadin, xanthopurpurin	madder types (*Rubia tinctorum* L. or *Rubiaceae* species)
		indigotin (small amount)	woad (*Isatis tinctoria* L.) or indigo (*Indigofera tinctoria* L.)
Red	red fringes	alizarin, purpurin, rubiadin, xanthopurpurin	madder types (*Rubia tinctorum* L. or *Rubiaceae* species)
Beige	repaired *clavus*	Luteolin	weld (*Reseda luteola* L.)

Dyeing with madder: the reproduction of the red colour of the fringes

The first case study concerns the red colour of the fringes (fig. 5). In the analysis, alizarin, purpurin, rubiadin and xanthopurpurin were detected which point to the use of madder types (*Rubiaceae* species). According to Jan Wouters and his collaborators, as well as Helmut Schweppe, species of *Rubiaceae* differ in composition as well as in dye yield.[44] *Rubia tinctorum* L. contains more alizerin than purpurin compared to *Rubia peregrina* L., which has more purpurin than alizerin. A ratio of at least 75% alizerin and 25% purpurin is presumably indicative of dyer´s madder (*Rubia tinctorum* L.). Other ratios might

43. See, Van Bommel 2015.

44. Wouters *et al.* 2008; Schweppe 1993, p. 231–232.

Figure 5. Red dyed fringes of *P. Vindob*. Stoff 256. (Photo: Ines Bogensperger © Austrian National Library, Vienna).

point to the use of other *Rubiaceae* species (or even mixtures of them), such as *Rubia peregrina* L. or *Galium* species. It might result from a special dyeing procedure, such as top dyeing of madder red with a woad or indigo vat, or a special treatment of dyer's madder after harvesting and before dying. Amongst the analysed late antique textiles, the ratio between alizarin and purpurin usually differs from "modern" madder: for example, the result of *P. Vindob*. Stoff 256 shows a higher content of purpurin.

In ancient dyeing recipes, madder is rarely attested. Out of the 83 recipes in *P. Holm.* and *P. Leid.* X, madder is only mentioned in four.[45] The first text refers to how to verify the madder quality (*P. Holm.* 125), the second has a list of various plants and insects for dyeing red (*P. Holm.* 133), and the remaining two are similar recipes about overdyeing of light blue wool with red (*P. Holm.* 112; *P. Holm.* 159).

All results of other textiles of the Papyrussammlung analysed in the course of the research project differ from the written evidence: out of 36 samples of red shades, 31 samples contain madder types; 11 samples contain additional dyestuffs to achieve orange or purple, or use other red dyestuffs like cochineal or alkanet.

Due to the lack of an ancient recipe where madder was used as the only main dyestuff, we had to turn to a modern recipe. As our first step, wool was prepared with alum and tartar, and dyed at 70°C (Table 2, nos. 1-6). Considering a previous dyeing experiment based on a passage in Pliny's *Natural History* (Plin. *Nat.* 35.42), we applied a liquid containing alum, vinegar and water with a brush on specific parts of a woollen fabric without a separate mordant bath.[46] Alum clearly modified the brightness of the colour, however, we could not observe any effect caused by tartar. Thus, we reduced the alum to 15%.

In the course of our practical experiments, we changed the amount of madder to 150% to achieve a more intense colour (fig. 6). The following experiments were dyed in a

45. Froschauer 2007, p. 703–704.
46. Rösel-Mautendorfer & Bogensperger 2017, p. 70–81.

Figure 6. Colour spectrum of madder dyed wool. (Photo © Helga Rösel-Mautendorfer).

cold dye bath at 22°C for 24 hours, with the exception of no. 8, which was additionally boiled for one minute after the cold dye bath. As a reference, we added wool that had not been in a mordant bath before (Table 2, nos. 7-9). The cold-dyed samples were redder than the samples of the hot dye. The best match was no. 8, where a cold dye was combined with boiling only over a short time. The sample without mordant was duller and the colour appeared more violet (no. 9).

Experiments with previously treated madder

For nos. 10 to 21, we used pre-treated madder. A first batch of madder roots was slowly dried at an average of 19°C. A second batch was desiccated at 100°C for 90 minutes and afterwards at 50°C for 90 minutes. A third batch with fresh roots was steamed in a sieve over boiling water for 180 minutes in a covered pot. Due to the drying process, the weight was generally reduced to approximately 75%. The colour of the roots differed after the drying process.

For the dye bath, we used prepared wool (14% alum) and 150% roughly ground madder per sample. We chose four different procedures: a cold dye bath at 22°C for 24 hours; a cold dye bath at 22°C for 24 hours with an additional boiling at 100°C for 1 minute; a hot dye bath at 70°C for 2 hours; and a hot dye bath at 70°C for 2 hours which was additionally boiled for 1 minute at 100°C (Table 2, nos. 10-21).

The results yielded a great variety of reds (fig. 6). Boiling for a short time after the cold or hot dye bath resulted in a darker shade. The cold dyed samples were paler than the hot dyed ones. A paler colour was obtained with the steamed roots. To get more intense hues, it is necessary to use a higher percentage of the dyestuff (about 200%). Overall, the colour seemed less yellowish than the first batch. The hot dyed wool of the air-dried roots showed the most intense colour. This, however, might be due to the constant temperature of the dye bath at 65°C.

The dyed samples were to be analysed by UHPLC in order to evaluate any effects of the ratio between alizarin and purpurin[47].

***Double-dyeing with madder and plants containing indigotin: the reproduction of the purple colour of the* clavi *and the* orbiculi**

The second case study examined dyeing of the reddish purple used for the ornaments of the tunic. According to UHPLC-PDA analysis, the components (indigotin, indirubin and isatin and alizarin, purpurin, rubiadin and xanthopurpurin) indicate a double dyeing of red madder and blue woad, or other *Indigofera* species, which results in a purple colour.

The sequence of the double dyeing was a crucial subject of discussion and decision for our experiments. Modern dyers use both ways, blue – red and red – blue.[48] To control the darkness and obscurity of the colour, it is easier in practical terms to dye red in the first step and blue

47. Scheduled for the end of December 2018.

48. Regarding the different techniques of mordant and vat dyeing, see Cardon 2007, p. 4–6; Schweppe 1993, p. 660–661.

Table 2: Summary of the dyeing experiments with madder.

No.	Mordant	Dyeing material	Source	Additives	Wool	Temperature	Duration	Colour	Comments
1	20% alum 6% tartar	130% madder, powder	Iran	-	Merino/yarn Eider wool/fibres	max. 70°C	2 h	orange	
2	20% alum 6% tartar	130% madder, powder	Iran	3% chalk	Merino/yarn Eider wool/fibres	max. 70°C	1 h 30 min	orange	paler than no. 1
3	20% alum 6% tartar	260% madder, powder	Iran	3% chalk	Merino/yarn Eider wool/fibres	max.70°C	2 h	orange	no significant difference in colour to nos. 1+2
4	20% alum 6% tartar	130% madder, small pieces	not specified	-	Merino/yarn Eider wool/fibres	max. 70°C	1 h 5 min	orange	more yellowish than no.1
5	20% alum 6% tartar	130% madder, small pieces	not specified	3% chalk	Merino/yarn Eider wool/fibres	max. 70°C	2 h	orange	more reddish than no. 4
6	20% alum 6% tartar	260% madder, small pieces	not specified	3% chalk	Merino/yarn Eider wool/fibres	max. 70°C	2 h	orange	no significant difference in colour to no. 5
7	15% alum	150% madder, powder	Iran	-	Merino/yarn Eider wool/fibres	22°C	24 h	red	
8	15% alum	150% madder, powder	Iran	-	Merino/yarn Eider wool/fibres	22°C 100°C	24 h 1 min	red	a bit darker than no. 7
9	no mordant	150% madder, powder	Iran	-	Merino/yarn	22°C	24 h	red	more pinkish than no. 7; dull
10	14% alum	150% roughly ground madder	Austria slowly dried	-	Coburger Fuchs /fibres	70°C	2 h	red	
11	14% alum	150% roughly ground madder	Austria slowly dried	-	Coburger Fuchs /fibres	70°C 100°C	2 h 1 min	red	darker than no. 10
12	14% alum	150% roughly ground madder	Austria slowly dried	-	Coburger Fuchs /fibres	22°C	24 h	red	lighter than no. 10
13	14% alum	150% roughly ground madder	Austria slowly dried	-	Coburger Fuchs /fibres	22°C 100°C	24 h 1 min	red	darker than no. 12, lighter than no. 10
14	14% alum	150% roughly ground madder	Austria desiccated	-	Coburger Fuchs /fibres	70°C	2 h	red-orange	
15	14% alum	150% roughly ground madder	Austria desiccated	-	Coburger Fuchs /fibres	70°C 100°C	2 h 1 min	red	darker than no. 14
16	14% alum	150% roughly ground madder	Austria dried by desiccation	-	Coburger Fuchs /fibres	22°C	24 h	salmon	lighter than no. 14
17	14% alum	150% roughly ground madder	Austria desiccated	-	Coburger Fuchs /fibres	22°C 100°C	24 h 1 min	salmon-orange	darker than no.16, lighter than no. 14
18	14% alum	150% roughly ground madder	Austria steamed before drying	-	Coburger Fuchs /fibres	70°C	2 h	light red	more bluish, brighter than nos. 10+14
19	14% alum	150% roughly ground madder	Austria steamed before drying	-	Coburger Fuchs /fibres	70° C 100°C	2 h 1 min	light red	darker than no. 18
20	14% alum	150% roughly ground madder	Austria steamed before drying	-	Coburger Fuchs /fibres	22°C	24 h	salmon	lighter than no. 18
21	14% alum	150% roughly ground madder	Austria steamed before drying	-	Coburger Fuchs /fibres	22°C 100°C	24 h 1 min	light red	darker than no. 20, similar to no. 18

Figure 7. Vat dyeing. (Photo © Georg Rösel).

in the second. In the vat, the wool is dyed in subsequent "dippings" until the desired purple hue is obtained (fig. 7). In the reverse order, it is more difficult to estimate a suitable blue for the first dyeing, in particular for an inexperienced dyer. This sequence runs the risk of obtaining too dark a blue.

However, in the ancient recipes, dyeing blue is mentioned first followed by a red overdyeing (*e.g.*, *P. Holm*. 111). For our experiments with purple, we started with a vat dye according to the sequence of the ancient recipes. We used an indigo-hydrosulphide vat, which gives a relatively quick result and works well with wool. Four different shades resulted from one dipping, two dippings, three dippings, and the last sample with one dipping in the depleted vat. In the second mordant dyeing, the dried madder roots were used with 15% alum. The dye bath was kept at 22°C for 24 hours with 150% madder. The experiments with one, two and three dippings gave a very dark purple shade compared with the original textile *P. Vindob.* Stoff. The light blue sample of the depleted vat, however, resulted in a reddish shade of purple, which in fact matches well with the original colour. It is noteworthy that the use of a light blue dyed wool is literally attested in the ancient recipes, γλαυκόσας τὰ ἔρια… (*e.g.*, *P. Holm.* 159, 1108).

Double dyeing with weld and indigoid plants: the reproduction of the green colour of the main fabric

The third case study concerned how to obtain the green colour of the ground weave of *P. Vindob.* Stoff 256. Following our previous discussions on double dyeing, we started with blue. Three samples were dyed in an indigo-hydrosulphide vat with one, two and three dippings. After the mordant bath with 15% alum, we dyed the samples with 200% weld at 90°C for 1 hour. As a reference, we used a wool sample pre-mordanted with alum in order to estimate the intensity of the yellow colour.

The green colour of the samples from one and two dippings matched reasonably well. However, for the reproduction of the original tunic, a large piece of fabric 155 × 350 cm was needed. Therefore, we cooperated with Joseph Koó, a professional indigo dyer. In order to estimate the intensity of the blue vat dye and thus the final green, we agreed to reverse the sequence, in other words, to dye yellow first. After mordanting (14% alum), the fabric was dyed together with woollen yarn with 155% weld for 2 hours at 80°C. The result was a rather uneven yellow colour due to the fact that the fabric was difficult to move in the dye bath. Interestingly, additionally added woollen yarn showed a different shade than the woven fabric (fig. 8). Thus, different kinds of wool, the quality and processing of the material apparently have an impact on the dyeing result.

We aimed to conduct this third experiment as close as possible under the conditions and circumstances of ancient times. Due to the large piece of fabric, we gained several essential insights into the actual dyeing process, the handling and the duration. The dye bath was first heated to 48°C. It took another hour to achieve 80°C, which was the maximum temperature because the large surface of the vessel, measuring 50 cm in diameter, led to a considerable temperature loss. Heating large amounts of water takes a relatively long time and is very resource intensive. It seems plausible that in ancient times, lower temperatures were used for dyeing, which would require more time to achieve an intense colour.

Our vessel turned out to be too small for the large textile, as it could not be stirred easily. One has to assume relatively large vessels were used in ancient times, in particular for dyeing woven fabrics. Nevertheless, to achieve boiling temperature for a large volume is challenging. In *P. Holm.* 110, 779, a vessel for a vat dye containing 15

Figure 8. Large fabric and yarns dyed in the same dye bath. (Photo © Helga Rösel-Mautendorfer).

μετρηταί is attested, which converts to *c.* 550 litres.[49] In comparison, a dyeing basin in J. Koó's modern workshop has a diameter of 1 m to a depth of approximately 4 m and can contain roughly 3000 litres (fig. 9).

For overdyeing with blue, we worked in J. Koó's workshop. His own vitriol vat mainly consists of water, indigo and lime. The dyeing was carried out as a cold dyeing. In order to achieve the exact colour of the original textile, the fabric was repeatedly dipped into the vat for 2 minutes each time. Between dippings, the fabric was dried in the air for 10 minutes to ensure a sufficient oxidation process. After dyeing, the fabric was rinsed out with cold water and dried in the open air. Our final results matched well with the original green colour (fig. 10).

Conclusion

The ancient texts reflect the importance and professionalism of dyeing craftsmanship. They highlight the logistics through reference to colour samples and they demonstrate the complexity of dyeing.

Dyeing experiments offer a good insight into the dyeing techniques and reveal some parameters which influence the colours. On the subject of madder, it was shown that even a slight change in the recipe results in a different hue. In the case of yellow, it has become significant how the type and the quality of the wool can influence the colour. Therefore, ancient dyers had to react according to the material in order to achieve the desired shade and to fulfil their customers' expectations. Experience and practical knowledge are crucial in estimating the correct colour, especially when wet, since different materials behave differently during the drying process.

When considering large quantities of fabric or fleece, certain conditions must be met. The size of the vessel is decisive for an evenly dyed result. Larger textiles were probably dyed in less hot dye baths, as a larger water surface leads to a considerable temperature loss.

49. Reinking 1938, p. 19–20; Halleux 1981, p. 139. On μετρητής, see Hultsch 1882, p. 589; 633: Table XX. So far, we have not found any exact measurements for dyeing pots from archaeological sites.

Figure 9. Vat dyeing in the professional dyeing workshop 'Blaudruckerei Koó'. (Photo © Ines Bogensperger).

Figure 10. Comparison of *P. Vindob.* Stoff 256 with, bottom right, a small sample of double-dyed fabric. (Photo © Ines Bogensperger).

Our experiments in the double dyeing of blue and red for purple confirmed the sequence of "blueing wool", which we have found in the ancient recipes. In practical terms, it was of course possible to change this sequence.

Texts, textiles and experiments reflect the complexity of ancient dyeing technology. Besides practical knowledge and experience, a certain amount of creativity and spontaneity was required to react to unforeseen circumstances caused by the material, the ordered colour, or the colour intensity of the dye. Attention had to be paid to the underlying logistics, since the materials required for dyeing had to be available from other sectors, such as agriculture, animal husbandry and mining. The often only seasonally obtainable materials presumably influenced the high value of dyed textiles because dyeing materials that have been stored too long loose their colour intensity. The reproduction of a particular colour is certainly a demanding challenge and may have required some kind of dyeing tests even in ancient times. The complex process, the *modus operandi* of the ancient dyeing industry, might have involved the exchange and the use of colour samples in order to provide an idea of the exact colour.

Abbreviations

- All abbreviations of Latin authors follow the index of the *Thesaurus Linguae Latinae*. Ancient Greek authors follow the abbreviations of the *Oxford Classical Dictionary*.
- All papyrological works and all references to papyri, ostraca, etc. follow J.F. Oates, R.S. Bagnall, S.J. Clackson, A.A. O'Brien, J.D. Sosin, T.G. Wilfong & K.A. Worp (eds.), *Checklist of Greek, Latin, Demotic and Coptic Papyri, Ostraca and Tablets*. Available at: https://library.duke.edu/rubenstein/scriptorium/papyrus/texts/clist_papyri.html (continually updated)
- The numbers of the dyeing recipes as well as the line numbers follow the edition of Halleux 1981.

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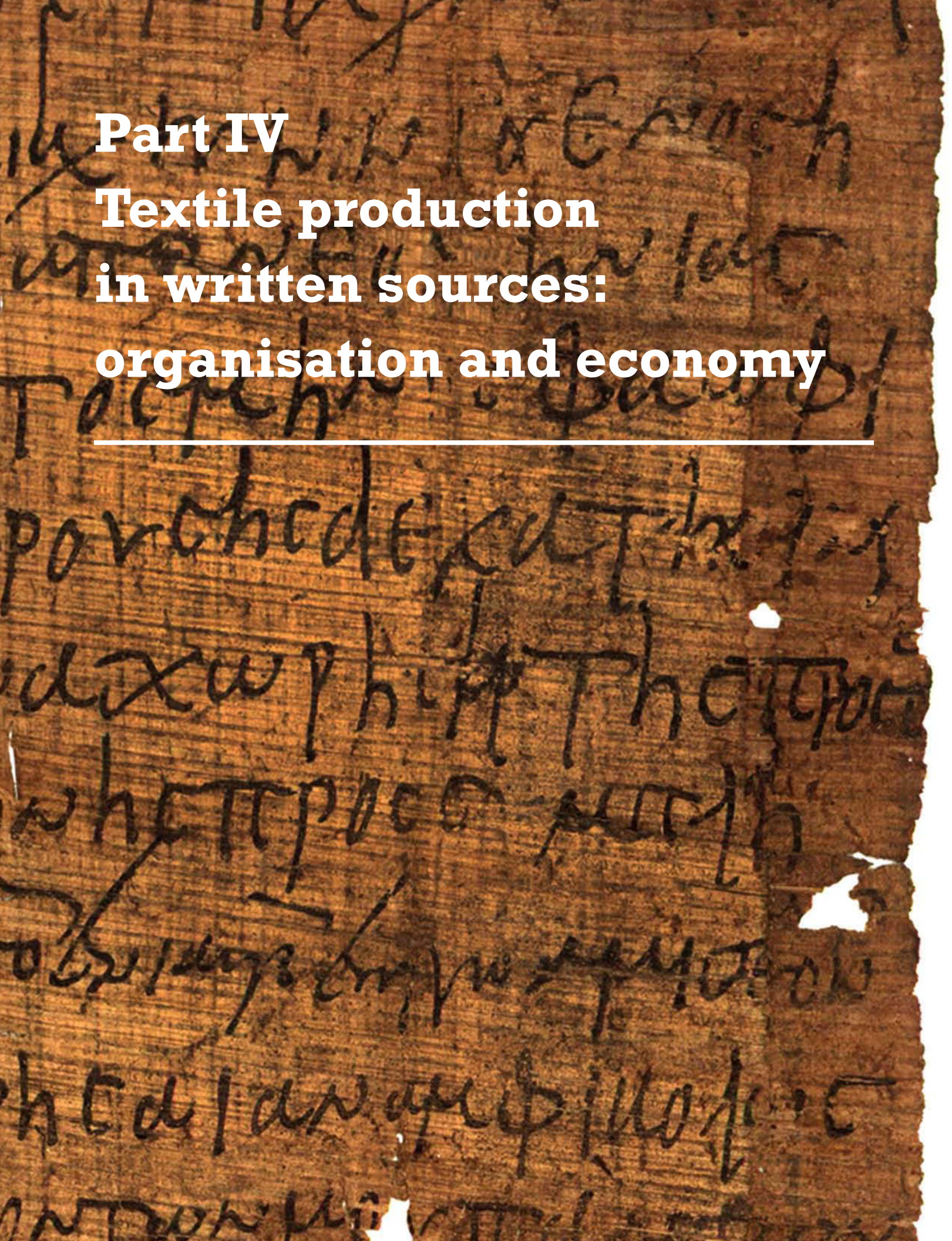

Part IV
Textile production in written sources: organisation and economy

Flax growing in late antique Egypt: evidence from the Aphrodito papyri[1]

Isabelle Marthot-Santaniello

Introduction: The unexpected scarceness of textual evidence for flax cultivation

While flax culture was a major economic sector in Egypt throughout antiquity and the medieval period, one can only agree with John R. Rea, the editor of *P. Coll.Youtie* II 68, when he says: "it has not escaped notice that surprisingly little information about [flax and linen] has been recovered from the Greek papyri".[2] By way of example, the specific word for the flax plant, *linokalamē*,[3] appears in Greek papyri only in around 60 of more than 60,000 published texts.[4] More specifically, the agricultural conditions set to produce flax are seldom visible in the texts: little more than twenty documents are relevant to this topic.

A first explanation for this lack of data concerning flax in the papyri is that the main region of flax production was the Delta, which has yielded almost no papyri because of its humid climate.[5] In a recent study, Katherine Blouin convincingly gathered the evidence for flax production in the Delta, specifically the Mendesian nome, underlying how this area enjoyed suitable conditions for flax growing. As she points out, Pliny the Elder, our main source on flax culture in Roman Egypt, listed four varieties of Egyptian linen, three of which are associated with towns located in the Northern Delta: Tanis, Pelusium and Bouto.[6]

This explanation is not fully satisfactory because, while the Delta was probably the main region of production, flax was also cultivated in the Valley and in such proportions that it should be more visible in the texts. Several sources can be mentioned to attest, if needed, that flax was also a cash crop in Upper Egypt. First, the fourth variety listed by Pliny refers to the city of Tentyris, modern Dendera. Medieval sources also mention flourishing centres of flax and linen in this part of the country: "When the merchant Ibn Ḥauqal described the countryside of Egypt around the middle of the tenth century, the distribution of cash crops was dominated by a certain specialization, with Aswan (Syene) noted for its abundance of date palms, Ashmunein for flax,

Published in Maria Mossakowska-Gaubert, ed., *Egyptian Textiles and Their Production: 'Word' and 'Object' (Hellenistic, Roman and Byzantine Periods)* (Lincoln, NE: Zea Books, 2020). doi 10.32873/unl.dc.zea.1087

1. Preliminary remarks on the present topic were part of my doctoral dissertation (Marthot forthcoming), defended in 2013. The present work was achieved as part of the SNSF-funded project n° 100015_162963 "Change and Continuities from a Christian to a Muslim Society — Egyptian Society and Economy in the 6th to 8th centuries". I would like to express my gratitude to Professor Jean-Luc Fournet and Mrs Florence Lemaire for providing access to their unpublished material, and to Mrs Jennifer Cromwell for her careful proofreading of this article.
2. *P. Coll.Youtie* II 68, introduction p. 457. Coptic documents seem more numerous on this subject.
3. *Linon* can refer both to flax and linen products. For a discussion on Greek words referring to flax, see Mayerson 1998, p. 223–225; for a lexicographical study, see Georgacas 1959, p. 253–269.
4. Papyri.info last consulted on August 2018. The present paper is mainly focused on Greek papyri but also draws upon Coptic evidence in the discussion.
5. This explanation for the limited evidence furnished by the papyri is given, for example, in the introductions to *P. Coll.Youtie* II 68, introduction p. 459 and to *P. Oxy.* XLV 3254–3262, p. 128.
6. Blouin 2014, p. 236.

'Fayyum' (the former Arsinoe) for fruit orchards and rice cultivation, Bahnasā (Oxyrhynchus) for its diversified textile industry, and so on".[7] In the documents from the Cairo Geniza, dating from the 11th century, twenty-eight varieties of flax are mentioned, "some of them are named for the location in which they were cultivated".[8] These places are not all identified but at least we can recognise from Upper Egypt the "Asyūṭī (Suyūṭī), Ashmūnī, Iṭfīḥī" and "Fayyūmī".[9] Indeed, a few papyri from Ashmunein (Hermopolis) and a more important group of a dozen papyri from Oxyrhynchus mention flax growing in these two cities in the 4th century AD.[10] Recently, Jennifer Cromwell studied textile production in Western Thebes as documented by Coptic papyri from the 6th to the 8th century and she analysed the attestations of flax production, in particular on land owned by the monastery of Epiphanius.[11] At the important monastery of Apa Apollo at Bawit in the Hermopolite nome, although its important body of documents illustrates wheat and wine production, only one text alludes directly to flax growing: a 7th- or 8th-century list of wine distribution for the workers hired for the harvest of flax.[12]

Who grew flax? Weavers and agricultural activities

Another explanation for the low number of papyri mentioning flax growing has been offered by Ewa Wipszycka in her seminal study of the textile industry in Roman Egypt: "Malheureusement, les sources gardent le silence au sujet de la participation des paysans au travail du lin brut; cet état des choses n'est pas uniquement dû au hasard des trouvailles des documents. Le travail du lin était exécuté par une population illettrée et, pour la plupart, non grecque; il n'était pas grevé d'un impôt spécial, il n'exigeait pas l'intervention de spécialistes".[13]

The most logical explanation as to the silence of the available sources would be that flax growing was common, done by illiterate peasants in almost any village as a domestic activity that sometimes produced surplus, which was sold to the weavers, and all this without the need of written documents. The same idea is further developed when Wipszycka listed the three ways through which a weaver could get his material, which is the "filé" or yarn. The first is to produce it from beginning to end by cultivating himself a plot of land with flax. The second is to receive it from the customer, who orders a piece of work. The third option is to buy it.[14] Concerning the first case, in which a weaver cultivates flax himself, Wipszycka warns the reader: "Je crois qu'il ne faut pas surestimer cette dernière source, d'autant plus que les renseignements à ce sujet sont très restreints. Une liaison aussi étroite entre l'industrie textile et l'agriculture nous obligerait à admettre un niveau très bas de la première, ce qui n'est pas confirmé par l'ensemble de sources".[15] For Wipszycka, the occupation of weaving was on a higher social level than that of agriculture. She had indeed gathered a few texts in which a weaver is seen cultivating flax: three land leases in which the lessee is a weaver who will sow flax himself (*SPP* XX 113 (AD 401), *P. Cair.Masp.* I 67116 (6th century), *P. Lond.* III 1072 (7th century), and a fourth document quickly summarized as follows: "Dans *P. Flor.* III 296 [6th century], un tisserand figure comme propriétaire".[16]

Weavers growing flax themselves in Aphrodito: some coveted tenants

Among these four texts, the second and the fourth are from the village of Aphrodito (Kom Ishqaw), located between Lycopolis (Assiut) and Panopolis (Akhmim) in the middle of the arable land on the west bank. This village is famous as the best-documented single village of late antiquity, on account of a thousand papyri found during the early 20th century.[17] New studies, recently undertaken under the

7. Banaji 2001, p. 6 and note 1, referring to Ibn Ḥauqal's book entitled *Configuration de la terre (Kitāb Ṣūrat al-arḍ)*.
8. Gil 2004, p. 84; Blouin 2014, p. 238 underlines that this naming practice concerns more than half the cases.
9. Gil 2004, p. 84 and note 11, which gives the location of some of the less obvious denominations, *e.g.* Tamawi being a village near Assiut.
10. See *P. Coll.Youtie* II 68, introduction p. 457–458 and *P. Oxy.* XLV 3254–3262.
11. Cromwell 2017, p. 215–216.
12. *P. Brux.Bawit* 49. Other evidence of flax production in the Hermopolite is given by *CPR* IV 48 (Busiris, AD 625), a contract in which fourteen villagers commit to deliver linen to a Persian official. On this text, see recently Delattre 2018, p. 212–215.
13. Wipszycka 1965, p. 20; see also Bransbourg 2016, p. 328 and note 77.
14. Wipszycka 1965, p. 44.
15. *Loc. cit.*
16. *Ibid.* p. 21, note 18.
17. For a historical overview of these finds, see Marthot 2016a, p. 161–162.

direction of Jean-Luc Fournet, focus in particular on the largest group of texts known as the "Dioscorus archive", which contains almost 700 papyri that span the entire 6th century.[18] Among them, nearly 100 land-leases and receipts were gathered and studied by Florence Lemaire, providing a better understanding of the archive. *P. Flor.* III 296, which was quickly characterized by Wipszycka as featuring a weaver mentioned as landlord, is in fact a draft of a letter similar to a petition,[19] and the situation described is much more complex. Jean-Luc Fournet, who is preparing a re-edition of this text, argues a dating between 548 and 565 and identifies the handwriting as that of Dioscorus himself. In this letter, Dioscorus complains to an unknown recipient/addressee about Papnouthis, a village headman (*protokōmētēs*)[20] who, among other misdeeds and without justified reasons, had arrested all the weavers (*linoüphoi* in line 40) from the adjacent village to the east, called Phthla. Dioscorus tried to have three of them immediately released, because they worked every year in his fields and paid his taxes due in gold.[21] Papnouthis refused: he had already forced all the weavers to sign documents committing them to sow flax for him and he even asked them for an advance payment of taxes. Dioscorus begs the recipient of this letter to give orders so that these men, "who have always sown flax" for him, can return to him so that he will be able to pay taxes.

Manpower was not specifically lacking in Aphrodito, and private account books demonstrate that many workers cultivated Dioscorus' fields.[22] *P. Flor.* III 296 illustrates clearly that having weavers cultivating flax in one's field was sufficiently profitable that some local figures used force to acquire them. The arrested weavers were apparently forced to sign an agreement with Papnouthis instead of dealing with Dioscorus as they usually did.

The other document from the archives that Wipszycka mentioned as being a land-lease attesting that weavers cultivated flax actually provides a more precise idea of the kind of agreement that Dioscorus may have had with weavers. In *P. Cair.Masp.* I 67116 (16 Phaophi /15 October 548), Biktōr son of Apollōs, a weaver (*linoüphos*), declares he is ready to sow with flax one *aroura (c.* 3,000 m²) that he has just rented from Dioscorus and that he owes him for the "rent, seeds and irrigation"[23] one *solidus* minus two carats, *i.e.* 22 carats, which he will pay at the third tax instalment (*katabolē*).[24] He pledges all his belongings as a warranty.

This type of agreement is peculiar. Typically, in agricultural leases from Aphrodito, the tenant only pays for the rent of the land, on which he can cultivate whatever he wishes. Irrigation costs and supply of seeds can be the object of special agreements between the landlord and the tenant.[25] At this period, the rent for one *aroura* of land, without irrigation or seed provided, is around five *artabai* of wheat.[26] According to a recent study, one *solidus* corresponds to ten *artabai* of wheat and thus one *artaba* corresponds to 2.4 carats.[27] A rent of five *artabas* is therefore worth 12 carats. Details with which to evaluate the cost of irrigation and seed are lacking.[28] Even if these extra costs are taken into account, the rent agreed by the weaver in *P. Cair.Masp.* I 67116 remains intriguingly high.[29]

The lease *P. Cair.Masp.* I 67116 and the petition *P. Flor.* 296 attest that it was a matter of importance that weavers sowed flax in the fields themselves. One could wonder if there was a technical skill or a specific gesture for this operation. Ancient Egyptian reliefs depict different movements

18. Fournet 2008, p. 307–343 (list of texts in Appendix 2); see Fournet 2016, p.121 for a distinction among the Byzantine papyri.
19. In his forthcoming re-edition, Jean-Luc Fournet labels this text as "supplique épistolaire".
20. There is, however, an ambiguity as to whether Papnouthis is one of the heads of Aphrodito or of the neighbouring village of Phthla.
21. Lines 43 to 45.
22. See, for example, *P. Cair.Masp*. III 67325 (various texts dated from AD 554 to 585).
23. The Greek words that are used are *phoros*, *spora* and *ardeusis*.
24. The *solidus* was a gold coin that could be subdivided into 24 carats (*keratia*).
25. See *e.g*. *P. Michael.* 46 (AD 559).
26. Rents are often difficult to establish, since the texts have preserved either the total amount and not the size of the rented property, or the size and not the amount. In *P. Michael.* 43 from AD 526, a *geōrgion* (*i.e.* a property with irrigation equipment) has an annual rent of 5 *artabai* (two-thirds wheat and one-third barley) per *aroura*, see the commentary in Keenan 1980, p. 147 and note 7. In *P. Hamb*. I 68 from AD 548, the rent of the arable land is 4 *artabai* of wheat and 1 *artaba* of barley per *aroura*. In *P. Vat.Aphrod.* 1 (discussed below), the rent is 5 *artabai* of wheat per *aroura* in a well-equipped property.
27. Bransbourg 2016, p. 320.
28. It is usually accepted that 1 *artaba* of wheat is required to sow 1 *aroura*. The price of 1 *artaba* of flaxseed is unknown and flax can be more densely planted than wheat, so a higher quantity of seed may be needed for the same surface.
29. The same rate of 1 *solidus* per *aroura* is attested in Thebes but also with variations, see Cromwell 2017, p. 215 and note 16.

for sowing flax than wheat. For example, in the tomb of Urarna at Sheikh Saïd (Middle Egypt) dating from the Middle Kingdom (21st to 18th century BC), "the man sowing cereal grain uses an overarm action, while the man scattering the flax seeds uses an underarm movement which is typical for the sowing of this crop".[30] The harvest of flax also differs from wheat since the plants are "pulled rather than cut, in order to obtain as long and straight a length of fibre as possible",[31] an operation made easier by the fact that flax has thin and shallow roots. Although flax certainly needed specific treatment, these operations do not seem so complicated that any peasant with a little experience could not achieve them. Another parameter seems more relevant to explain what is at stake when weavers cultivated flax themselves: they must have had a good knowledge of the plant, and the younger the plant is harvested, the finer the thread. Therefore, if they are in charge of the agricultural operation, they can decide what quantity to harvest and when in order to produce fine or coarse thread.[32]

Growing flax may have been the only agricultural operation with which a weaver was or chose to be concerned. The special agreement in which the landlord provided seed and dealt with irrigation costs may therefore have been practical for a person with otherwise little connection to field work. The linseeds collected along with the stems could be used or sold to produce oil. Safely storing grains from rodents, thieves and other misfortunes over the year may have been a trouble from which the weaver wanted to save himself.

Who were the weavers in Aphrodito?

Little additional information is found on the social and economic status of weavers (*linoüphoi*) in the village of Aphrodito. Among the 700 papyri that form the Dioscorus archive, only three other texts mention this profession.

First, *P. Cair.Masp*. II 67147 (AD 532) is a list of payments for a special levy, which starts with a section related to various professions: first the weavers (col. 1, l. 3), and then fullers, tool makers, leather workers, sculptors, bakers, oil makers, coppersmiths, clothes menders, barbers, and most certainly others, but the bottom of the papyrus is not preserved. The amounts that each trade had to pay are also damaged, preventing the possibility of any relative comparison of their importance.

The second text, *P. Cair.Masp.* III 67288, is the end of a list of payments by individuals, the exact date and purpose of which are lost. Of around 150 preserved entries, two concern weavers and two others the son(s) of weavers: Pabik (col. 2, l. 5), NN son of Pkolobos (col. 2, l. 34), Phoibamōn (sic) son of Thallous (col. 2, l. 37) and NN son of Patermouthis (col. 5, l. 17). These men are among the group that pays the lowest rate, one-third solidus, while others pay one-half or a whole solidus. This suggests a rather low social class. The document, however, does not prove any regularity in the paid amounts according to trade: for example, some fullers paid one-third solidus, some one-half, and others one solidus.

Last, a weaver named Andreas is mentioned in a private account, much damaged and to be published by Fournet, without any obvious connection with Dioscorus or flax related activities.[33]

Distinctive features for flax growing seen in Aphrodito

Specific agricultural agreements

There is in Dioscorus' archive one other text that explicitly mentions flax growing, this time without the participation of weavers: in *P. Cair.Masp.* II 67128 (dated of 27 August 547) a deacon of Aphrodito, named Psaïs son of Bēsios and Tasaïs, acknowledges his debt regarding "the rent, seeds,

30. Vogelsang-Eastwood 2000, p. 270 and fig. 11.2. For flax sowing in pre-industrial Europe, see Heuzé 1893, p. 24: "Exécution des semis: On sème la graine de lin à la volée. […] Cette semaille est difficile. Elle réclame des ouvriers bien exercés, des semeurs qui sachent coordonner le pas avec le bras. Elle n'est parfaite que lorsque la graine a été disséminée très uniformément" (I am grateful to Hélène Cuvigny for this reference).

31. Vogelsang-Eastwood 2000, p. 270. Two examples of New Kingdom representations of harvesting wheat by cutting and flax by pulling out are: Deir el-Medina, tomb of Sennedjem (TT1); Elkab, tomb of Paheri. Another suggestion of this opposition can be found in the vocabulary used: the editor of the Coptic document *P. Brux.Bawit* 49, Alain Delattre, underlines in his commentary to line 1 that a specific verb, ϩωωλϵ meaning "to pluck", is used in particular to refer to flax harvesting, see Crum 1939, p. 667b.

32. Vogelsang-Eastwood 2000, p. 270: "The timing of the harvesting is important, because the age of the plant affects the uses to which the fibres can be put. Thus, if the flax plants are harvested while still young and green, then a fine textile can be produced, and if it is harvested when slightly older, then the fibres are suitable for a general, good quality cloth. However, if the harvesting takes place when the plants are old, then the resulting flax is usable only for coarse cloth and ropes".

33. P. Lond. inv. 0493 mentioned by Ruffini 2011, p. 610, no. 38. The presence of this individual in P.Lond. inv. 0569b (Ruffini 2011, p. 610, no. 39) is now called into question.

and irrigation" of one *aroura* that he will cultivate with flax. The land is located in the northern part of Aphrodito's territory, close to a place named "of Athanasia". The due amount is one *solidus* minus two carats, the same high rent recorded in the weaver contract *P. Cair.Masp.* II 67116. The end of the document bears the mention of a previous agreement between Psaïs and Dioscorus regarding two *arourai* in an area called Piahse, which is known to be in Phthla. Two years later, in *P. Cair.Masp.* II 67129 (14 August 549), the same person has become a priest and draws a similar contract, except this time for three *arourai*. The *arourai* are in two groups: one is explicitly near the place of Athanasia and the two others are not located, but it is tempting to think that they are the same two *arourai* in Phthla. The first editor thought that the later document was only to cultivate wheat, because the rent includes a payment in kind. However, the passage mentioning the nature of the growing is damaged and wheat could have been cultivated in one part of the rented plots while flax was in another part. This hypothesis would justify the amount of the rent: it amounts to two *solidi*, each minus two carats, to which are added one-third *solidus* and 1.5 *artaba* of wheat, which corresponds to 11.6 carats, a figure close to the 12 carats that was the regular rent of an *aroura* planted in wheat. The *aroura* close to the place of Athanasia would on this occasion be sown with wheat, while the two others would be sown with flax. In this hypothesis, we have a second piece of evidence for flax growing in Phthla in addition to the petition/letter *P. Flor.* III 296.

As already mentioned, this type of agreement concerning "the rent, seeds, and irrigation" is very rare. In P. *Cair.Masp.* II 67251 (18 October 549), Iakybis (*sic*) son of Abraam, also a priest, draws a similar acknowledgement of debt to Dioscorus: the same high rent of one *solidus* minus two carats for one *aroura*, to be paid this time at the second levy of taxes. Nothing is said on the location of the plot or on the nature of its cultivation, it is thus possible that it was flax. Would priests be, like weavers, specifically interested in this "all inclusive" agreement due to their limited agricultural activities? There is indeed only one other lease of field in Aphrodito in which a priest may have been the tenant, but it is damaged and incomplete.[34] A deacon, however, clearly takes on lease a well-planted and equipped property at his own expense in *P. Lond.* V 1696 *recto*.[35] The nature of the growing that he will do on the land is not specified, but the rent is 7 *artabai* of wheat per *aroura*, a slightly higher rate than usual, probably due to the specific trees and equipment on the rented property.

Howard Comfort studied the group of texts formed by *P. Cair.Masp.* I 67116, *P. Cair.Masp.* II 67128, 67129 and 67251 from a juristic point of view.[36] He underlines that 67128 and 67129 are the real leases, drawn in August, while 67116 and 67251 are acknowledgements of debt when Dioscorus actually gave the seed in October.[37] A fifth text, *P. Mich.* XIII 668 (9 July 555), was published after Comfort's study and completes the picture: it is a receipt, also drawn by the same notary, Pilatos, for "the rent, seeds, and irrigation" of two *arourai* issued by the landlord in July, *i.e.* after the harvest and threshing. This time, the tenant is Phoibammōn son of Triadelphos, a well-known figure in Byzantine Aphrodito with many agricultural business activities.[38] Therefore, in his case, the argument that, due to his limited experience, he may have found a higher rent profitable – as long as he did not have to care for the provision of seeds and the irrigation – does not hold. The situation is, however, different: first, the amount is not given and thus it cannot be proved that the rent was higher than a regular one. Second, and most of all, this receipt is in fact an acknowledgement of debt from the landlord to the tenant, because the rent is that of the following year. James Keenan has studied another group of papyri in which Phoibammōn, as the tenant, is seen lending money to his landlord, a soldier named Samuel who descends into deeper and deeper debt.[39] A last aspect of this receipt needs to be underlined: the two *arourai* are said to be, in line 3, in "fat earth" (*lipara gē*), a rare expression that points to an important parameter that needs to be taken into consideration in the present discussion.

34. *P. Cair.Masp.* I 67108 (547) is the beginning of a document in which a priest, along with his brother, seems to sublease land belonging to Dioscorus' family. The syntax and lacunas of this text make it difficult to understand what precisely is going on.

35. Jean-Luc Fournet has identified P.Lond. inv. 01603b as belonging to the same document and has edited the verso, see now *SB* XXVI 16529 (526). Florence Lemaire has produced a preliminary edition of the *recto*, which is currently unpublished.

36. Comfort 1936, p. 293–299.

37. Comfort surprisingly considers that Dioscorus wrote these documents himself, see Comfort 1936, p. 293: "En étudiant les baux fonciers de cette époque, j'ai été frappé par plusieurs documents de sa main". They are, however, signed by a notary named Pilatos, see Diethart & Worp 1986, p. 30–31. Therefore parts of Comfort's argument about the young Dioscorus trying new juridical ways and later learning from his trip to Constantinople (p. 298–299) need to be taken with caution.

38. Fournet 2016 p. 115–141 on Phoibammōn's archive, which differs from Dioscorus' one; Keenan 1980, p. 150–154 on Phoibammōn's business.

39. Keenan 1980, p. 145–150.

Specific settings

This expression "fat earth" is only attested in four papyri: *P. Vat.Aphrod.* 1, the already discussed *P. Mich.* XIII 668, *P. Cair.Masp.* II 67128, and 67129. Before returning to the two latter texts, the former requires a brief summary. *P. Vat.Aphrod.* 1 (23 April 598) is a land lease of a large, well-equipped property, the rent of which conforms with the regular rate, in line 19-20, of five *artabai* of wheat per *aroura*. This contract contains several specific stipulations, among which, in line 22, the fact that the landlord should receive the full product of two *arourai* that have to be taken, one in "fat earth", the other in a "wheat-bearing plot" (*sitophoron gēdion*). The adjective *sitophoros* meaning "bearing wheat" is abundantly attested between the 2nd century BC and the 2nd century AD to qualify *gē*, "earth", and refers to arable land, grain land. From the 3rd century AD, it becomes rare and the three occurrences in the Aphrodito papyri are the more recent ones. In addition to leaving the entire product of two *arourai* to the landlord, the tenant will have, in line 24, to fertilise one *aroura* (possibly the one in the wheat-bearing plot) and he will pay, in lines 26-27, three *solidi* each minus one carat. In exchange for the produce from these two *arourai* and the given money, the tenant will receive ten *arourai* free of rent, representing for him a saving of 50 *artabai*, *i.e.* 5 *solidi*. This shows that the two *arourai* kept by the landlord are both worth 1 *solidus* each, a rate that recalls the one seen in the leases mentioning flax growing, among which are *P. Cair.Masp.* II 67128 and 67129.

The two contracts, *P. Cair.Masp.* II 67128 and 67129, between Psaïs, the deacon and later priest, and Dioscorus include a specific indication as to where flax should be cultivated. The expression in both texts is damaged: in 67128, in lines 15 to 18, ἐν περισύνῳ̣ς σιτοφ[ό]ρ[οις γῃδίοις]… ἐγγὺ̣ς [λιπαρᾶς(?)] γῆς and in 67129, in lines 14-15: ἐν περ[ι]σύνου σιτοφόρου γῃδ[ίῳ], [ἐγγὺς(?)] λιπ̣α̣ρ̣[ᾶς] γῆς. The adjective *perisunos* (περίσυνος) was interpreted by the first editor as meaning "surroundings".[40] The rented *aroura(i)* would then have been next to wheat-bearing plot(s) and close to "fat earth". S.G. Kapsomenakis argued that this form comes instead from *perusi* (πέρυσι), which is well attested in Classical Greek and means "a year ago, last year".[41] The reading of the adverb *eggus* meaning "close to" is very tentative in 67128 and restored in the lacuna in 67129. It can be deduced from *P. Vat.Aphrod.* 1 that the two categories differ. The meaning must therefore be that the land had been cultivated with wheat the year before and its soil was now in the state of being "fat". This indicates a justified crop rotation for flax, since, according to Pliny, "no other plant grows more quickly: it is sown in spring and plucked in summer, and owing to this also it does damage to the land".[42] The concern of not exhausting the soil could then explain why Psaïs would have sown flax near the place called Athanasia in AD 547 (*P. Cair.Masp.* II 67128) and in the two *arourai* in Phthla in AD 549 (*P. Cair.Masp.* II 67129). This suggests that Dioscorus had agreements for crop rotations in his various fields. The same idea is found in the lease *P. Oxy.* XLV 3256 (Oxyrhynchos, AD 317-318): of 26 *arourai* owned by the landlord, the tenant rents, to sow flax, only the 13 *arourai* "which are lying fallow" (*tas en anapausi ousas*) in line 8.

An explanation for these two kinds of soil is given in a passage by Galen[43] in which cereal land (cultivated with wheat and barley) is opposed to land in which trees grow (vines, fig trees, olive trees), the latter being called *lipara gē,* because of the presence of clay (*pēlos*). The Greek word for clay is, to my knowledge, not present in leases, but in a 7th/8th century AD Coptic document, the leasehold property dealt with in the text is formed by "two plots of clayland under the sloping ground".[44]

Pliny describes the suitable soil for flax as follows: "flax is chiefly grown in sandy soils, and with a single ploughing".[45] Katherine Blouin, however, has discussed this assertion: "Pliny's claim regarding the suitability of sandy soils to flax culture must be nuanced in the light of modern knowledge on the biology of flax, which shows that the best-suited soils for this crop are heavy, loamy ones that retain water".[46] She provides the following precision: "Loam is a type of soil made of 7 to 27% of clay, 28 to 50% of silt, and less than 52% of sand".[47] This definition, showing the presence of clay, fits well with Galen's description of *lipara gē*.

If "fat earth" is where trees could be planted, it needs to be in a specific location. One could also wonder if "fat earth"

40. *P. Cair.Masp.* II 67128, p. 9, commentary to line 5: "Le mot doit signifier 'les environs' ".
41. Kapsomenakis 1938, p. 64–65, n. 2.
42. Pliny, *NH*, 19, 2, 7.
43. Galen, *SMT*, 9, 165.
44. *O. CrumST* 37, 5–6 mentioned in Richter 2009, p. 208.
45. Pliny, *NH*, 19, 2, 7.
46. Blouin 2014, p. 234.
47. *Ibid.,* p. 234, n. 87.

could have been the result of a particular preparation of the plot, which would be covered by floodwater longer than the other cereal lands. In the *Description de l'Égypte*, the memorandum about contemporary agriculture gives the following information: "Comme toutes les terres inondées naturellement ne sont pas situées au même niveau, on réserve les plus basses, sur lesquelles les eaux ont séjourné le plus longtemps, pour la culture du lin [*Linum usitatissimum*]".[48] The cases of "fat earth" in Aphrodito were not all located in a single spot, but were scattered either in the northern part of the village territory (the place of Athanasia in *P. Cair. Masp.* II 67128), in the eastern part (*P. Vat.Aphrod.* 1), or even further to the east in Phthla (*P. Flor.* III 296 and possibly *P. Cair.Masp.* II 67129), a village whose territory did not reach the Nile.[49] Some areas may have been in a lower level, close to key points of the irrigation system, about which little is known.[50] The only mention of irrigation equipment in these texts is that the *aroura* in fat earth is "south of the cistern" (*lakkos*), while the wheat-bearing plot is "east of the dyke, south of the great channel" (*amara*) in *P. Vat.Aphrod.* 1, 22-23. Special preparation of the land before the end of the flood period would explain that agreements concerning flax growing had to be made in August (*P. Cair.Masp.* II 67128 and 67129).

The *Description de l'Égypte* provides further information: "[Dans la province de Syout], le lin est semé au solstice d'hiver. La terre, qui a été submergée naturellement, ne reçoit aucune préparation. La meilleure est celle qui a été le plus longtemps inondée : comme alors elle est à l'état de boue, la semence s'y enfonce assez pour n'avoir pas besoin d'être recouverte. […] Les champs ensemencés en lin n'exigent aucun soin jusqu'à la récolte. Elle se fait au commencement d'avril, trois mois et demi après les semailles".[51] There are, however, some discrepancies with the picture drawn from the Aphrodito papyri: sowing seems to have occurred in October rather than December and, more important, flax needed more watering than that provided by the Nile flood alone. This is confirmed by a Coptic lease, *P. Mon.Epiph.* 85, in which two men take on lease land from a priest and agree to "sow two fields with flax for you […] and work them with the farmer's craft and to give them their waters".[52] Considering the Greek documentation, John R. Rea underlined: "In eleven of our thirteen leases the text allows us to deduce that there was an unusually good supply of water",[53] with mention of land being near to an irrigation machine or associated with embankments of irrigation works or even located in the marsh (*en tō helei*).[54]

Evidence of flax growing from Oxyrhynchos is mostly from the Leonides archive (*TM Arch* 132)[55] and would require a detailed analysis that goes beyond the purpose of the present paper. The case of the village of Ision Panga, however, stands out, with five flax leases located in its territory. On the basis of what has just been demonstrated for Aphrodito, and flax growing in general, one would expect rich soil and a good water supply. Jane Rowlandson, however, described the village as follows: "But towards the desert edge agricultural prosperity declined. Ision Panga had more than its fair share of problems, with land sanded over, land damaged by floods, and more evidence of fodder than of cereal crops".[56]

Conclusion

Texts from Dioscorus' archives provide precise insights into flax growing in an Egyptian village. In many cases, the practice of subsistence farming explains why this crop is not as visible as may be expected from the vast linen trade that operated in Egypt. As with vegetables, flax must have been cultivated on small plots together with wheat. When flax was grown on a large scale, Aphrodito papyri suggest that it was in a median position between wheat and vine farming: it was done on cereal land, but required some specific treatments, one being "fat earth", the other good irrigation. The need to rotate crops in order not to exhaust the land would explain that plots could not be registered as flax land for specific taxation. From

48. Girard 1809–1829, §11 p. 539.

49. The location of the property concerned with *P. Vat.Aphrod.* 1.

50. On this subject, see Marthot 2016b, p. 1871–1885.

51. Girard 1809–1829, §11 p. 540.

52. Wilfong 1999, p. 219–220.

53. *P. Coll.Youtie* II 68, introduction p. 459.

54. *P. Herm.* 22, 11 (Hermopolis, AD 394); see also *P. Coll.Youtie* II 68, line 18–22: "[We undertake to lease your land]… on condition that we… are to have, rent free, for the retting of the flax, the reservoir (*limnē*) which you possess …close to the cistern (*lakkos*) of Diogenis and which is within (?) the pool (*charubdis*) of Pasiniscus". *Charubdis* is a rare word also found in fishing contexts.

55. Luijendijk 2010, p. 575–596.

56. Rowlandson 1996, p. 18.

the tenant's point of view, weavers may have found it convenient to grow flax themselves, but that could also be true for other social categories, including deacons and priests who willingly chose this plant cultivation. From a landlord's point of view, having tenants cultivating flax seems to have been a lucrative business and a practical way to pay the taxes due in gold. As there were not so many weavers in a given village, rivalry at times erupted among landlords, even leading some of them to procure this type of agreement by force. This battle over flax sowing is a telling illustration of the economic significance of this crop in the village microcosm.

Abbreviations

All papyrological works and all references to papyri, ostraca, etc. follow J.F. Oates, R.S. Bagnall, S.J. Clackson, A.A. O'Brien, J.D. Sosin, T.G. Wilfong & K.A. Worp (eds.), *Checklist of Greek, Latin, Demotic and Coptic Papyri, Ostraca and Tablets*. Available at: https://library.duke.edu/rubenstein/scriptorium/papyrus/texts/clist_papyri.html (continually updated)

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Textile production in the papyri: the case of private request letters

Aikaterini Koroli[1]

Introduction

Throughout the "papyrological millennium", that is from the 3rd century BC to the 8th century AD, both administrative and private life in Egypt were largely based on letters. Apart from oral communication, letter writing, mostly on papyri and ostraca, was the only available form of communication for the inhabitants of the land of Nile when they needed to get in touch and exchange information with people who did not live in their immediate surroundings. Papyrus letters, written by and sent to private, ordinary people and not to the authorities, composed in the Greek vernacular and intended to fulfill a wide range of communicative goals, fall into the category of Greek private correspondence. These short, authentic, non-literary letters deal mainly with the practicalities of everyday life, including, of course, craftwork, business and financial issues. It is not, therefore, surprising that a considerable percentage of them are related to textile production and use. Textiles are, of course, but one of the numerous recurring topics to which these letters refer; yet both the quantity and quality of this evidence should not be ignored. The special value and interest of private papyrus letters — as compared to other kinds of non-literary papyri also containing information on ancient fabrics — lies in that they make it possible for us to explore the words or phrases of interest within a helpful linguistic environment. Moreover, letters often contain enough clues to enable the reconstruction of the situational context, especially when they are well preserved.

The present paper focuses on a distinct category of private papyrus correspondence, that of request letters.[2] My special focus will be on letters referring to demanding, urgent situations; these letters constitute striking proof of the crucial and irreplaceable role that request papyrus letters played in the processes of manufacturing, trading and use of Egyptian fabrics.

Published in Maria Mossakowska-Gaubert, ed., *Egyptian Textiles and Their Production: 'Word' and 'Object' (Hellenistic, Roman and Byzantine Periods)* (Lincoln, NE: Zea Books, 2020). doi 10.32873/unl.dc.zea.1088

1. FWF-Research Project "Texts and Textiles in Late Antique Egypt" (P-28282), Austrian Academy of Sciences (ÖAW), Vienna (Austria).

2. For a thorough analysis of requesting in private papyrus letters, see my text-driven study (Κορολή 2016), which is based on a vast corpus of *c*. 8000 private letters on papyri and ostraca dated to the Roman (31 BC–AD 330), Byzantine (AD 330–AD 641) and early Arab periods (AD 641–AD 799) of Egypt. In both that study and the present article, business letters are considered to be a sub-category of private letters. Business activities constitute an integral part of private life. Furthermore, very often business is family business. Finally, topics related with business and financial life are interwoven with other issues of private life, so a line cannot really be drawn between private and business correspondence (Κορολή 2016, p. 45).

   In the present paper, letters dated from the Ptolemaic period (323 BC–31 BC) have also been included. The terms "directive" and "request" are used indiscriminately as general terms denoting all ranges of directive speech acts. The interpretation and translation of the passages cited are the ones offered in the papyrological editions and/or the secondary bibliography; where none is available, translations are my own.

Theoretical framework and methodological considerations

The frequency of requesting and the classification of private papyrus letters

As already noted, private papyrus letters correspond to the various, everyday communicative needs of their senders, both practical and social. Requesting is by far the most common of these communicative purposes. The high frequency of directive speech acts in the main body of private letters is one of the most noticeable features of these texts.

Requests in papyrus correspondence are direct, since their formulation points unequivocally to the communicative intention of the senders, and, consequently, are easy to locate.[3] In the core of the directives there are verbs either in the imperative or the subjunctive mood (more rarely their infinitive or simple future), *i.e.* grammatical markers of deontic modality.[4] Alternatively, the infinitive, the participle, the imperative, the subjunctive or the future of these verbs, or a subordinate clause of purpose which include them depend on performative verbs, for example ἐρωτῶ and παρακαλῶ (in the first person indicative, in the second or third person subjunctive, or as participles),[5] verbs such as θέλω and καταξιόω (in the imperative or subjunctive),[6] verbal phrases including ποιέω (*e.g.* πᾶν ποίησον, καλῶς/εὖ ποιήσεις),[7] or, much less frequently, deontic verbs (*e.g.* δεῖ, χρή and ὀφείλω)[8] or other verbs combined with purpose clauses.[9]

Being so frequent, directives can serve as the basis for the classification of private papyrus letters in the following categories:

a) request letters, *i.e.* letters in which requesting constitutes the main or one of the main communicative goals of the ancient writers and

b) letters where requesting is not the main or one of the main communicative purposes.[10]

3. For a thorough presentation of the formulation of requests in private papyrus letters (including rarer cases) with many examples, see Κορολή 2016, p. 100–126. Indirect requesting is very rare in papyrus letters; for examples, see Κορολή 2016, p. 211–217.

4. Cf. the use of imperative, subjunctive and simple future, respectively, in the following examples: *BGU* III 822, 9–10 (after May 5, AD 105?; see HGV): **γράψον** Κουπανηοῦτι | περὶ τῆς οἰκίας ("write to Koupaneous about the house"; see Bagnall & Cribiore 2006, p. 191); *P. Rain.Cent.* 162, 6 (7th century AD?; see BL XII 165): καὶ **γράψῃς** μοι τὸ πρᾶγμα ("Und schreibe mir, wie es sich entwickelt"; see edition); *O. Claud.* I 139, 5–7 (c. AD 110): λοι|πὸν **γράψεις** μοι ποίας τει|μὴν (l. τιμῆς) αὐτὰ ἔλαβες ("Now, write to me at what price you bought them"; see edition).

5. Cf., *e.g.*, *P. Tebt.* II 408, 5–11 (AD 3): **παρα|καλῶ** σε περὶ υἱῶν | μου τῆι φιλοστορ|γίᾳ τῶν περὶ Σωτή|ριχον **μὴ ἐâσαι** | πυρὸν αὐτοῖς δοθῆ|ναι ("… I entreat you about my sons, not to allow that, out of their regard for Soterichus and his people, wheat be given to them"; see edition); *O. Claud.* I 155, 5–6 (2nd century AD): **ἐρω|τῶ** σε **πέμψεις** μοι αὐτήν ("I ask you to send it to me"; see edition); *P. Flor.* III 303, 2 with BL XII 72 (6th century AD): **π̣[α]ρ̣[α]κ̣ᾳ̣[λ]ῶ̣** τὴν σὴν ἀρετὴν **ὅπ[ω]ς ἀγοράσῃς** τὰ πεντακισχίλια κοῦφα ("I beseech your excellence to buy the five thousand empty jars"; translated by A. Koroli); *P. Oxy.* VIII 1165, 11 (= Sel.Pap. I 167) (6th century AD): **παρακληθῆτε** (hand 2) \οὖν/, (hand 1) …, **ποιῆσαι** αὐτοὺς ἀπολυθῆναι ("… be persuaded … to have them released"; see the edition); *P. Oxy.* XII 1581, 4–7 (2nd century AD): **ἐρωτηθείς**, ἀδελφέ, | Σαραπίωνα **μὴ ἀφῇς** ἀργεῖν | καὶ ῥέμβεσθαι, ἀλλὰ εἰς ἐργασί|αν αὐτὸν βάλε ("At my request, brother, do not let Sarapion be idle and roam aimlessly, but put him to work"; see Bagnall & Cribiore 2006, p. 362).

6. Cf., *e.g.*, *P. Stras.* IV 286, 4–7 (mid-4th century AD): **καταξιωσάτω** σου ἡ φιλαδελφικὴ | διάθεσις, δέσπο̣τα, Στέφανον | διαφέροντα τῇ ἐμῇ βραχύτητι | τοῦτον **ἀφεθῆ[να]ι** ("Si degni, o signore, la tua fraterna disposizione di congedare questo Stephanos, che è importante per la mia pochezza"; see Tibiletti, 1979, p. 188); *P. Oxy.* XVI 1941, 5–7 (5th century AD): **θέλ\η/|σον ἀποστῆναι** τῆς γεωρ|γίας μηχανῆς Στύμονο\ς/ ("Haz el favor de retirarte del campo de labranza de Estimón"; see O'Callaghan 1963, p. 129).

7. Cf., *e.g.*, *P. Freib.* IV 56, 5–9 (1st/2nd century AD): **εὖ ποιήσεις προνοήσα|σα** κοπῆναι τὸ καλαμί|δ̣ιον προχρήσασα τοὺς | μισθοὺς μέχρι οὗ̣ κατέλ|θω{ι}("… you will do well to arrange for the reeds to be cut, advancing the wages until I come down"; see edition); *P. Iand.* VI 102, 23 (6th century AD): **πᾶν π]οίησ̣ο̣ν**, **πώλησον** ("… tue alles, um sie, wenn möglich, zu verkaufen"; see edition).

8. Cf., *e.g.*, *P. Oxy.* XIV 1678, 10 (3rd century AD): **δεῖ** σε αὐτὸν **προσέ{σ}χειν** ("… you ought to beware of him"; see edition).

9. *P. Alex.* 26, 19–21 (2nd/3rd century AD): τα{ο}ῦτα μέν σοι **γράφω,** | **ἵν̣α̣** τὴν χώραν μου **ἀ̣[ναπ]ᾖ̣ηρώσῃς** | [ἐν] τούτῳ τῷ ἔργ[ῳ ("I'm writing to you these words, so that you represent me / take my place in this task"; translated by A. Koroli).

10. The occurrence of commonplace, stereotypical exhortations to the recipient to greet one or more persons or take care of his/her health is not enough to consider a private letter as a request letter. These exhortations belong to the standardised/formulaic elements of private papyrus correspondence through which the senders express their concern for the recipient and his or her relatives; cf. *O. Did.* 373 (before c. AD 88–97): Ἀλέξανδρος Κασσίωι κονδούκ[τορι] | χ[αίρειν·] | περὶ τοῦ κρεα̣δίου, οὗ̣ μοι εἴρηκες (l. εἴρηκας) «δέξε (l. δέξαι) [παρὰ] | Νιλᾶτος πέντε {εἰ}στατήρων», οὐδὲ ἐξ αὐ[τοῦ] | πέπρακεν· καὶ ἤθελαν (l. ἤθελον) οἱ στρατιῶτε (l. στρατιῶται) ἀγοράσαι | καὶ οὐκ ἤθελε πωλῆσαι, ἀλλὰ λέγει ὅτι «εἰς | Βερ<ε>νίκην αὐτὸ πέμπω.» **ἄσπασαι** | Σαβῖνον καὶ Γάιον καὶ Πρίσκ̣ος (l. Πρίσκον). | ἔρρωσο. ϛ (or ἔρρωσο{ς}) ("Alexandros to Cassius conductor, greetings. Concerning the meat, (about) which you said to me: 'Take five staters' worth from Nilas', but he has not sold from it and the soldiers wanted to buy and he would not sell, but says: 'I sent it to Berenike'. Greet Sabinus and Gaius and Priscus. Farewell. The 6th (?)"; see edition); see Κορολή, 2016, p. 193–202, where more examples are offered.

The first of the two aforementioned categories is the broadest. Requesting seems to be the most common reason why a letter would be composed. It is often combined with providing information, which also constitutes a good reason for writing and sending a letter.[11] Private letters related to fabrics are not an exception.

A small percentage of letters providing information on fabrics do not include any requests. This is the case, for instance, regarding *O. Claud.* II 293 with BL XI 295; XII 296 (*c.* AD 142/143); its sender provides the recipient with varied, practical information and assures him that he has done everything he had asked:

> Νειλίων Πετεαροηρι τῷ υἱῷ πολ(λὰ) χα(ίρειν). | καθὼς ἐνετείλου μοι, εὐθὺς ἔτι <ε>ἰσῆλ|θε Ἀπολλῶς, τὸ ἱμάτιόν μου τέθει|κα καὶ δέδωκα αὐτῷ (δραχμὰς) η. αὐτῷ | τὸ ἱμάτιον δέδωκα. οὐ γὰρ ἠμέλουν | εἴπας σοι. Παρθενοπαῖος δὲ ὧς ἄρτι | οὐ δέδωκε τὰ χάλκινα. | ἀσπάζετ(αί) σε Σαραπιόδωρος πολλά. | ἔρρωσο. | λέγει δὲ καὶ ὁ Δριλλόμυς ὅτι «<ε>ἰς τρίτην | ἐνενκῶ (l. ἐνέγκω) σοι τὰς δύο κοτύλας τοῦ | ἐλαίου». ἐγὼ δὲ σὲ οὐ κατακεχρω|μάτικα ἀλλὰ πεμπομέ̣|νο̣υ, ἐπί σ̣ε̣ ⟦- - -⟧κα | . . . . α̣ . κα.[12]

Similarly, the sole purpose of the sender of the very short *O. Claud.* II 296 (second half of 2nd century AD) is to send a piece of information:

> Ἀχιλλᾶτι. ἔπεμ|ψά σοι τὸ πάλλι|όν σου ἐπιγεγραμ|μενῳ (l. ἐπιγεγραμμένον) ὀμόμα|τί σου πλατέ|οις γράμ|μασιν.[13]

Nevertheless, in most cases, letters referring to fabrics are full of directives. The correspondents involved used request letters to co-operate, to make decisions, to divide labour, to merchandise, to negotiate and to solve problems.

In the following three letters from the Ptolemaic, Roman and Byzantine period respectively, requesting is the main communicative goal of the sender, which is obvious from the content of their main body. All three texts are related to fabrics either partly or exclusively:

> *P. Mich.* I 13, 1-5 (= *PSI* VI 556; 257 BC): εὖ ἂν ἔχοι εἰ ἔρρωται Ἀπ[ολλ]ώνιός τε καὶ σὺ [ἔ]ρρω[σαι· ὑγιαίνομεν δὲ καὶ] | ἡμεῖς. ἐκομισάμην παρ' Ἰατροκλείους ἐρίων ὁλκὴν (τάλαντα) β. **γράψ[ον]** οὖμ (l. οὖν) μοι εἰ τεσσαρακοντ[αμναῖα $\overline{\gamma}$ ἢ ταλαντιεῖα] | γένηται δύο στρώματα, ἢ ταλαντιεῖον ποιῶμεν καὶ τὸ [(τάλαντον) τὸ] ἄλλο φυλάττω[μεν ἕως ἂν ὑμεῖς παραγένησθε]· | καὶ τὴν ταχίστην τοῦτο **ποίησον**. **γράψον** δὲ καὶ πότε ὑ[πο]δεχώμεθα [Ἀπολλώνιον, ἵνα κατὰ καιρὸν παρα]||σκευασθῆι αὐτῶι ἡ οἴκησις.[14]

> *P. Oslo* II 56, 3-8 with BL II.2 212; BL III 123 (2nd century AD): **εὖ ποιήσεις ἀγορά<σας>**

11. Expressing the sender's interest, reverence or even affection for the recipient and sometimes others such as the recipient's relatives, mostly by means of greeting, wishing, thanking or flattering the recipient, demonstrates the need to maintain family and social bonds and is an element inherent in the very composition of private letters. It is found either in the main body of the letter or in other parts of it, like the opening and closing formulas and the verso containing the information about the addressee. Nonetheless, this is very rarely the purpose of the letter writing; for a rare example, see *P. Köln* II 108 (= *SB* XII 11243; 3rd century AD): Φ[ιλόνεικος . . . .] . [- - -] | Κυρίλλᾳ χαίρειν. | πρὸ τῶν ὅλων ἀσπά|ζομαί σε καὶ τὸν κύρι[ό]ν | μου Ζωΐλον καὶ Πλου|τίαιναν καὶ Πανταρχίδα | καὶ Θερμοῦθιν καὶ Σωτη|ρίδα καὶ Εὐτυχίαν καὶ Κα|λόμαλλον καὶ Ἡρακλέ|ωνα καὶ Ἀρεοῦν, Εὐθη|νίᾳν, Σαραποδώραν, Κύ|ριλλαν τὴν μεγάλην καὶ τοὺς παρ' ἡμῶν πάν|τας. ἀσπάζεται Πλου|τίων Ἡρακλέωνα. ἐρρῶσθαί σε εὔχο(μαι). | [Κυρ]ίλλᾳ π̣(αρὰ) Φιλονείκου ("Philonikos … grüßt Kyrilla. Vor allem grüße ich dich und meinen Herrn Zoilos und Plutiaina, Pantarchis, Thermuthis, Soteris, Eutychia, Kalomallos, Herakleon, Hareus, Euthenia, Sarapodora, die große Kyrilla und alle unsere Hausgenossen. Pluton grüßt Herakleon. Ich wünsche dir Wohlergehen. An Kyrilla von Philonikos"; see edition, as well as the Italian translation offered by Tibiletti 1979, p. 157); for more examples, see Κορολή 2016, p. 260–262.
12. "Neiliôn à son fils Petearoèris, un grand salut. Comme tu me l'as enjoint, aussitôt qu'Apollôs est arrivé, j' ai mis mon vêtement en gage et je lui ai donné 8 drachmes. Je lui ai donné le vêtement. Car, je ne négligeais pas la chose, puisque je te l'ai dit (?). Jusqu'ici Parthénopaios n'a pas donné les sous. Toutes les amitiés de Sarapiodôros. Porte-toi bien. Notre Drillomys dit aussi 'je t' apporterai dans deux jours les deux cotyles d'huile'. Moi je ne t'ai pas - - -"; see edition. The verb κατακεχρωμάτικα at the end of the preserved fragment (ll. 12–13), which is neither fully transcribed nor translated by the editor, could mean "colour completely". Given the bad condition of the writing material here, it is not certain whether it refers to textiles.
13. "À Achillas. Je t'ai envoyé ton manteau marqué de ton nom en grosses lettres"; see edition.
14. "If Apollonios and you are both well, it would be good. I myself am keeping well. I received from Iatrokles two talents' weight of wool. Write to me then if it is to be made into three mattresses of 40 minas each or two of one talent each, or if we are to make one mattress of one talent and keep the other talent until you yourselves arrive; and do this as quickly as possible. Write to me also when we are to expect the visit of Apollonios, in order that the house may be made ready for him in good time"; see edition.

μοι ἐν Βουσῖρι χιτῶ(νας) | λινοῦς δύο στερεὰ καθάρε<ι>α καλὰ | ἕως (δραχμῶν) μ, ἐπικαρσίω(ν) Διοσπόλεως ζεῦ|γος καλών (l. καλόν), βαλανάριν μοναχόν, ἡμι|τύλιν (l. ἡμιτύλιν) καλὸν εἴ τι μείζω — **βλέπε** οὖν **μὴ | ἀμελήσῃς** — ἄλ̣λ̣ο̣ χείρω τῆς Σάεως.[15]

P. Rain.Cent. 77, 2-21 (5th–6th century AD):
σφυρα στεμματ̣ [- - -] κ | τ̣ὰ ἐλαφρ( ) [- - -] | καὶ ἑτερ( ) σφυρ( ) ἄλλη χρω̣ δ | καὶ ἑτέρας ἄλλας χρ[- - -]̣ . γ | καὶ δεσμ(ίδιον) στεμμ( ) γ | στιχάρι<ο>ν α | στρώματα β | μαφόρτια β | προσκεφάλ(αιον) α | ἰθμὸς χαλκούμ(ενος) α | **δέξασθαι (l. δέξασθε)** ταῦτα π(αρὰ) Ψαΐου τοῦ | ναύτου τοῦ δεσποτικοῦ | καὶ **κελεύσατε** ταῦτα πεμφθῆ[ναι] | [εἰ]ς τὴν οἰκίαν μ\ου/ ἄνω [ε]ἰς Ἑρμ[οῦ] | [πό]λιν καὶ ἀντιγράψαι [μο]ι περὶ | ὑ̣ποδ̣[ο]χῆς τούτων· σὺν θε̣ῷ̣ γὰρ | ἔ̣πομαι τούτοις μο[υ] τοῖς γράμμασιν· | καὶ **φρόντισαι** δὲ περὶ τῆς {παρα} | παρακλήσεως ὧν ἐπαρεκάλεσ̣ά̣ | σοι δ(ιὰ) γραμμάτων ἕνεκεν ἐμοῦ.[16]

The sender of *P. Mich.* I 13 asks the recipient to send him a letter containing specific instructions about the manufacturing of mattresses (ll. 2-3), and to do so as soon as possible (l. 4), whereas in ll. 4-5 he submits a request irrelevant to fabrics. The sender of *P. Oslo* II 56 asks the recipient to send him a long list of both garments and furnishing textiles (ll. 3-7) and asks the recipient not to be neglectful (ll. 7-8). Finally, the sender of *P. Rain.Cent.* 77, 2-21 asks the recipient to receive some products, to order their transfer to the sender's home and the sending of a letter to him, and, in general, to take care of everything he has asked by means of his letters.

Directives such as the one attested in *P. Mich.* I 13, 4 (καὶ τὴν ταχίστην τοῦτο **ποίησον**, "and do as quickly as possible") and the stereotypical request in *P. Oslo* II 56, 7–8 (**βλέπε** οὖν **μὴ | ἀμελήσῃς**; "see to it that you don't forget anything") play a subsidiary role, in the sense that they merely stress the necessity of the satisfaction of other (*i.e.* the basic) requests. Ancient writers often include this kind of directive in their request letters to make sure that the recipients will not be neglectful.

In all three aforementioned request letters, the directives dealing with textiles refer to the same topic. Nevertheless, this is not always the case. For example, the two directives contained in *P. Mich.* III 218 (= *SB* III 7250), 10-12; 13-14 (AD 296) concern different topics although they are both related to fabrics: καὶ **ἑτοί|μασον** τὰ σύνεργα τοῦ κιθωνίου σου | καὶ τοῦ {ε}ἱματίου…καὶ **ἑτύ|μασον (l. ἑτοίμασον)** τὸ δερματίκ[ι]<ό>ν μου.[17]

Frequently, requesting is not the only main communicative goal of the sender. In some request letters the directives related to textiles co-exist with information related to textiles but also concerning different topics; cf., *e.g.* the information provided in ll. 6-8 (with BL VI 81) of the aforementioned *P. Mich.* III 218: καὶ ἀφῆκα τὰ ἐρίδια | σεαυτῇ ἵνα ἤ (l. εἴ) τι θέλ<ε>ις ἀναλώσῃς σε|αυτῇ. [18]

Finally, in request letters like *P. Oxy.* LVI 3855 (c. 280/281), the directives contained in ll. 8-19 are irrelevant to textiles, whereas the information provided by the sender in ll. 4-5 concerns the preparation of a *chitonion* (τὸ κιθώνι<ό>ν̣ σου ἐποίησα | τμηθῆναι).[19]

15. "You will do good to buy for me in Bousiris two linen sturdy clean *chitonas* of good quality that cost no more than forty drachmas, a pair of checkered clothes of good quality from Diospolis, only one bath-towel / bag (?), a good half-sized cushion, if you find a larger — see to it that you don't forget anything — and another cheaper one from Sais"; ll. 3–6 (until μοναχόν) are translated by A. Koroli; for the translation of ll. 6–8, the meaning of ἡμιτύλιον or ἡμιτύλιν, as well as the meaning of καθάρεια, see Bogensperger & Koroli 2018 and Bogensperger & Koroli 2019a; the interpretation and translation of ἐπικάρσια as "checkered clothes" is offered by Droß-Krüpe 2018.
16. "Körbe (?) mit Kränzen (?): 20, und zwar die leichten: und weitere Körbe mit anders gefärbten: 4; und weitere andere …: 3; und Bündel von Kränzen: 3; Hemd: 1; Deeken: 2; Kopftücher: 2; Kopfkissen: 1; kupfernes Sieb: 1. Nehmt diese Sachen in Empfang von Psaios, dem Schiffer des kaiserlichen (Schiffes), und gebt Anweisung, dass sie geschickt werden zu deinem Haus, nach Hermupolis hinauf, und dass man mir Antwort schicke betreffend den Empfang dieser Sachen. Denn mit Gottes Hilfe werde ich diesem meinem Brief folgen. Und kümmere dich auch um meine Bitte, d.h. um die Dinge, um die ich brieflich gebeten hatte, um meinetwillen"; see edition.
17. "Also prepare the material for your tunic and your overcloak … Also get my leather coat ready"; see Rowlandson 1998, p. 150, no. 114; on σύνεργα, see, among others, Gonis 1998, p. 185 (n. to l. 17), who suggests the translation "materials", and specifically "yarn for weaving".
18. "I dispatched the fleeces for you, so that, if you want, you can use them for yourself"; see Rowlandson 1998, p. 150, no. 114, who offers a different interpretation of the passage as compared with that offered in the edition.
19. "I have had your tunic cut [from the loom?]"; see edition; on vocabulary concerning tunics, see Mossakowska-Gaubert 2017.

Request letters as a distinct category of private papyrus letters

As expected, diversity is one of basic characteristics of private papyrus correspondence in general and of request letters in particular. At the same time however request letters bear common features, in the sense that their writers seem to draw from the same source of rhetorical patterns, expressive means and strategies in order to succeed in their aim, *i.e.* to be convincing. This is why request papyrus letters constitute a distinct text type among private papyrus letters and non-literary papyri in general.

In addition to the recurrent ways of formulation already discussed above, the typical features of requesting in papyrus letters can be sought in the structure, *i.e.* the organization of the epistolary text. Direct requests constitute the core of thematic textual units. These units contain the thematically relevant co–text of the requests, if any, which functions as the preparation or supplement of the requests submitted. The organization of these thematic textual units is therefore based on the following rhetorical pattern: *preparation for the directive – formulation of the directive – supplement of the directive*. Thematically relevant directives belong to the same textual unit.

The above-mentioned organisational pattern varies, of course, depending on whether it is complete as well as on the special function of the preparation and/or the supplement, as is obvious from the following, characteristic examples.

In *P. Oxy.* LVI 3871, 2-4 (6th/7th century AD), the supplement of the request justifies its submission:

directive: **αἰτῶ** τὴν ὑμετέραν γνησίαν ἀδελφότητα τὸ ὁλαίγε<ι>ον καρακάλλιν τὸ παλαιόν, ὅπερ | ἔλαβεν ἀπὸ τοῦ κναφέως, **πέμψ[α]ι** μοι δ[ι]ὰ Θεοδώρου τοῦ λαμπροτάτου μειζοτέρου[20]
supplement: ἐπειδή, ὡς οἶδεν, ἠλλάγησαν οἱ ἀέρες[21]

In *P. Mich.* I 13 (= *PSI* VI 556), 2 the sender provides the recipient with useful information before submitting the two thematically relevant requests in ll. 2-4:

preparation: ἐκομισάμην παρ' Ἰατροκλείους ἐρίων ὁλκὴν (τάλαντα) β
directive$_1$: **γράψ[ον]** οὖμ (l. οὖν) μοι εἰ τεσσαρακοντ[αμναῖα γ̄ ἢ ταλαντιεῖα] | γένηται δύο στρώματα, ἢ ταλαντιεῖον ποιῶμεν καὶ τὸ [(τάλαντον) τὸ] ἄλλο φυλλάττω[μεν ἕως ἂν ὑμεῖς παραγένησθε]
diretive$_2$ *(repetition of directive*$_1$*)*: καὶ τὴν ταχίστην τοῦτο **ποίησον**[22]

In *P. Mert.* III 114, 3-25 (late 2nd century AD), the abovementioned structural pattern is attested in full. The function of the preparation for the two directives contained in this letter is different. The sender here tries to impose psychological pressure regarding the recipients by expressing his certainty about their concern for his own and his father's clothes. The first directive is supported by detailed information; the second, thematically relevant and equally basic request is supplemented by the assurance of the sender that he will do whatever is necessary.

preparation$_{1, 2}$: καὶ χωρὶς τοῦ γράφειν με | οἶμαι καὶ ὑμᾶς πεφρον|τικέναι τῶν ἱματίων | μου [ἐ]γβάντων τῶν | τοῦ πατρός μου, εἰδό|τες (l. εἰδυίας) μου τὴν προαίρε|σιν ὡς αἰσθανομέ|νῳ ποιοῦσαι (l. ποιούσας)[23]
directive$_1$: ὥστε | οὖν **γρά[φ]ω** ὑμ{ε}ῖν **ὅ|πως** ἐνεργοῦσαι αὐ|τὰ λ{ε}ίαν ἰσχνοτέ|ραν κρόκην **ποιήση|ται (l. ποιήσητε)** αὐτά[24]
supplement$_1$: ἐπειδὴ γὰρ | εὗρον στήμονα πρὸς | (δραχμὰς) η̄ τὸ ἀν' εἴκοσι στά|θμιον καὶ λ{ε}ίαν ἰσ|χνόν. καὶ γὰρ ἀγορά|ζω ἐκεῖ πορφύραν | πρὸς (δραχμὰς) δ τὸν στατῆρα | ὁλκῆς δ[25]
directive$_2$: ν[ ]θυ | σαι δὲ αὐτὰ **δηλώ|σατέ** μοι[26]
supplement$_2$: κ[αὶ] ὃ δέ|ον ἐ<σ>τὶ πο[ι]ήσω{ι}[27]

20. "I request your true brotherliness to spend me the old pure goat-hair cape with the hood, which you got from the fuller, by Theodorus the most splendid μειζότερος …"; see edition.
21. "… since, as you know, the weather has changed"; *ibid.*
22. For the translation of the passage, see n. 14.
23. "Even without my writing to you I imagine that you have begun to think about my clothes now that my father's are finished (?), since you know my wishes and that you are making them for a person of discrimination"; see edition.
24. "And so I'm writing to you in order that when you are working on them you make the thread for the woof very much finer"; *ibid.*
25. "… because I have discovered a thread for the warp at 8 dr. the . . . . *stathmion* and it is very fine. For I am buying purple there at 4 dr. the stater's weight"; *ibid.*
26. "When you are engaged on spinning them (?) let me know…"; *ibid.*
27. "… and I will do what is necessary"; *ibid.*

Finally, there are request letters such as the above-cited *P. Oslo* II 56, 3-8, where the directives are not framed by any kind of preparation and/or supplement:

> *directive*$_1$: **εὖ ποιήσεις ἀγορά<σας>** μοι ἐν Βουσῖρι χιτῶ(νας) | λινοῦς δύο στερεὰ καθάρε<ι>α καλὰ | ἕως (δραχμῶν) μ, ἐπικαρσίω(ν) Διοσπόλεως ζεῦ|γος καλών (l. καλόν), βαλανάριν μοναχόν, ἡμι|τύλιν (l. ἡμιτύλιν) καλὸν εἴ τι μείζω … ἄλλο χείρω τῆς Σάεως
> *directive*$_2$ (repetition of *directive*$_1$): **βλέπε** οὖν **μὴ | ἀμελήσῃς**[28]

It should be noted that the writers of all of the aforementioned examples try to be as clear as possible for the recipient by using specifications concerning the fabrics either in the directive itself or in its framing. Because of the difficulties involved in letter sending, they tried to avoid any misunderstanding due to insufficient information.

The object of the requests that are related to fabrics

As already noted, private papyrus letters deal almost exclusively with the practical side of life, nevertheless, the diversity of topics is noteworthy. The object of requests concerns various everyday, practical and/or family or social issues.[29] This thematic diversity is also apparent in the objects of the requests related to fabrics, which can be classified as shown in the Table at the end of the article.

Usually, request letters dealing with textiles contain requests falling into different thematic categories, even if they concern the same topic; cf., *e.g.*, *O. Did.* 353, 3-10 (before? c. AD 77–92):

> **μὴ** οὖν, ἄδελφε, **ἀμελήσῃς** μου ἀλλὰ **δέξαι** | τὸν γαυνάκην παρὰ Λογγείνου καὶ τὰς ἑξήκο|ντα δραχμὰς καὶ **δὸς** τὸν γαυνάκην καὶ | **βάψον** αὐτὸν κώκινον (l. κόκκινον). **δὸς** αὐτὸν Χρησίμ|ῳ τῷ Δέξκτ<ρ>ου τοῦ μεσσικίου. **μὴ** οὖν **ἀμελ|ήσῃς** ἠάν (l. ἐάν) σοι δοῖ (l. δῷ). εἰ δὲ μή, **γράψον** μοι καὶ ἐρῶ | τῷ κεντυρίωνι τούτω (l. τοῦτο [or τούτῳ]) λέγῳ·· «δέξαι [αὐτὸ?]|ν εἰς οἰκίαν μου.»[30] (receiving, giving, dyeing of the same finished garment, as well as the sending of a letter about it).

Similar instances are furnished by *P. Oxy.* III 531 (= *W. Chr.* 482; *C. Pap. Hengstl* 83), 12-15 (2nd century AD):

> **κόμ[ι]σαι** διὰ Ὀν|νωφρᾶ τὰ ἱμάτια τὰ λευκὰ τὰ δυ[ν]άμενα | μετὰ τῶν πορφυρῶν φορεῖσθαι φαινολίων, | τὰ ἄλλα μετὰ τῶν μουρσίνων **φορέσεις** (receiving and use of garments);[31]

P. Oxy. LXVII 4629,13-15 (6th/7th century AD):

> καὶ περὶ τῶν δύο μνᾶς (l. μνῶν) ἐρέ̣ας | **παρακαλῶ ζητῆσαι** παρὰ Λιμενίου καὶ | αὐτὰ<ς> **πέμψον** μοι (production of an oral text and sending of materials).[32]

Letters like these are informative as far as the whole process of manufacturing and the transactions are concerned.

It is also possible that one and the same request belongs to more than one of the aforementioned thematic categories; cf., *e.g.*, *P. Oxy.* LVI 3853, 4-6 (3rd century AD):

> τὰ ἱμά|τια ἐὰν ἦν (l. ᾖ) γεγονότα **μὴ [δ]ιαπέμπῃς** μοι ἄχρις | ἂν δηλώσω σοι περὶ αὐ̣τῶν (sending of garments and production of an oral or written text).[33]

It is also possible that the sender asks for fabrics along with different kinds of goods; cf., *e.g.*, *P. Oxy.* VI 937, 26-27 (3rd century AD):

> **[π]έμψον** τὸν μα|φόρτην σου καὶ τὸ κεράμιο̣ν τοῦ γάρους καὶ δικότυλον ἐλαίου χρηστοῦ.[34]

28. For the translation of the passage, see n. 15.
29. What is requested becomes obvious either in the directive itself and/or its framing, *i.e.* its thematically relevant co-text functioning as either its preparation or supplement.
30. "Now, don't neglect me, but receive this cloak from Longinus and the sixty drachmas and give the cloak and have it dyed scarlet. Give it to Chresimos the slave of Dexter, the discharged soldier. So, do not neglect this if he gives it to you. If not, write to me and I shall tell the centurion … receive [him?] into my house …"; see edition.
31. "Receive by Onnophris the white robes which are to be worn with the purple cloaks, the others you should wear with the myrtle-coloured (?) ones"; see edition; cf. the German translations offered by Hengstl 1978, p. 212 and Schubart 1923, p. 87.
32. "… and concerning the two *minae* of wool, please seek them from Limenius and send them to me"; see edition; cf. Bagnall & Cribiore 2006, p. 231.
33. "When the clothes are finished, don't send them over to me until I let you know about them"; see edition.
34. "Send your cloak and the jar of pickled fish and two *cotylae* of good oil"; see edition.

Finally, there are rarer cases of requests, which do not pertain to any of the above presented broader thematic categories; cf., *e.g., P. Mich.* III 201, 4-9 with BL IX 159 (AD 99):

> **καλῶ|ς** ο<ὖ>ν **ποιήσαṭαι (l. ποιήσετε) μελήσαιτε (l. μελήσετε)** ἡμ|ῖν περὶ τῶν ἁλ[ο]υρ<γ>ῶν τῶν δού|ω (l. δύο), μὴ νὰ (l. ἵνα μὴ) ἄλλος ἐκξενίκῃ (l. ἐξενείκῃ) αὐτὰ | καὶ τὰ {ε}ἱμάτι[α] τὰ σουβρίκια καὶ | τὼ (l. τὸ) παλλιώλιν (l. παλλιόλιον) αὐτῶν (l. ὑμῶν αὐτῶν?). The sender asks the recipient "to take thought about the two purple robes (?), in order that no one else may take them away";[35]

P. Oxy. VII 1069, 18-20 (3rd century AD):

> τὴν | πεδείσκην (l. παιδίσκην) μου δὲ πρὸ<ς> λόγον | **ἀνάγκασον** φειλοπονεῖστε (l. φιλοπονεῖσθαι). The sender asks the recipient to ensure that his slave-girl "be properly industrious".[36]

Requesting in an imperative tone: two case studies

As is obvious from the above cited examples, the senders of request letters try to strike a balance between two kinds of linguistic strategies, namely the strategies giving the epistolary text an imperative tone and the politeness strategies, *i.e.* various expressions of friendliness, reverence, admiration or even affection. The latter compensate the recipient for having to satisfy the request submitted by the sender. The imperative tone is codified in various ways, either commonplace or unusual. Using these linguistic strategies, the senders express very clearly and intensely their will; by doing so, they aim at the immediate reaction of the recipient.[37]

The imperative tone is striking in a considerable proportion of letters, including letters related to fabrics. This is the case when one or more of the requests submitted by the sender concern an urgency and/or when its sender wants to adopt a strict or even accusatory attitude towards the recipient, if a problem has been caused because of his/her negligence, irresponsibility or malevolence. This imperative style of writing therefore echoes the worries or the fears, the anger or the indignation that the senders experience due to difficulties or problematic situations. Request letters, like all private papyrus letters, reflect in a very vivid manner the internal world of their senders.

Focusing on the imperative tone helps us to comprehend the importance of private correspondence in the textile industry. In what follows, I will present two characteristic examples dated from Roman times and dealing with the transfer of warp and weft, namely *P. Berl.Zill.* 9 (AD 68) and *SB* VI 9026 (2nd century AD). The senders of the letters in question are facing demanding, urgent situations. Their requests concern problems that must be solved. Their intention is to make their texts effective, *i.e.* convincing, so that the recipient satisfies their request as soon as possible. The strategies to which they resort in order to achieve their goal are very frequent in documentary papyri.

The main body of *P. Berl.Zill.* 9 (ll. 3-14) deals only with one topic, *i.e.* the transfer of warp and weft in an imperative and criticising tone. The text is structured as follows:

> *preparation*$_{1, 2, 3}$: ἐτάξου μοι πρὸ τῆς ᾱ τοῦ Φαῶφι | ἐλθεῖν ἐπὶ τὰς κρόκας καὶ τὸν στή|μονα τῶν ἱματίων, καὶ οὐκ ἦλθες (ll. 3-5)[38]
>
> *directive*$_1$: **καλῶς** οὖν **ποιήσῃς** ἐξαυτῆς **ἐλεύ|σῃ** πρὸς ἐμέ (ll. 6-7)[39]
>
> *supplement*$_1$/*preparation*$_2$: δεῖ γὰρ αὐτὰ ἕως | τῆς δεκάτης ἐκτμηθῆναι, | μή ποτε χρεία γένηται κατα|πλεῦσαί με εἰς πόλιν (ll. 7-10)[40]
>
> *directive*$_2$: ἐὰν δὲ μὴ | μέλλῃς ἔρχεσθαι, πάλιν μοι | ἐξαυτῆς φάσιν **πέμψον** (ll. 10-12)[41]
>
> *supplement*$_2$: ἵνα | ὧδε αὐτὰ ἀναβαλῶ (ll. 12-13)[42]

35. "Please be so good as to take thought about the two purple robes (?), in order that no one else may take them away, and the clothing, the hoods and their mantle"; see edition; cf. White 1986, p. 156.
36. "Make my girl be properly industrious"; see edition.
37. The interaction of these linguistic strategies with linguistic strategies of politeness gives a request letter its particular tone and style: on this topic, see Κοροlή 2016, p. 231–256; see Koroli's forthcoming article offering a thorough discussion about the function and interaction of politeness and imperative tone markers in request papyrus letters.
38. "Du hast dich mir gegenüber verpflichtet, vor dem 1. Phaophi zu kommen, um die Einschlagfäden und Kettenfäden für die Mäntel zu holen, bist jedoch nicht gekommen"; see edition.
39. "Du wirst also gut tun, sogleich zu mir zu kommen"; *ibid.*
40. "Man muss nämlich dieselben vor dem 10. ausschneiden, damit es nicht nötig werde, dass ich mich zur Stadt einschiffe"; *ibid.*
41. "Wenn du aber nicht zu kommen beabsichtigst, dann sende mir sofort abermals Nachricht, …"; *ibid.*
42. "… damit ich (selbst) sie in dieser Weise auf den Webstuhl aufschlage"; *ibid.*

directive$_3$ (repetition$_2$): **βλέπε** | οὖν, **μὴ** ἄλλως **ποιήσῃς** (ll. 13-14)[43]

The imperative tone is codified in various ways. First of all, the sender starts his letter with a complaint concerning the inconsistent behaviour of the recipient; the latter had promised that he would come to get the warp and weft but did not keep his promise. The adverb ἐξαυτῆς ("immediately"; l. 6), contained in the first directive, stresses the urgency. The reason for the sender's worries is mentioned in ll. 7-10 functioning as the supplement of the *directive*$_1$ and, at the same time, as preparation of *directive*$_2$: these materials have to be cut by the tenth of the month. The imperative tone becomes more obvious with the submission of the second request; the recipient is asked to send a message should he not appear. The sender chooses to close his letter with a commonplace request, formulated only to stress the necessity of the satisfaction of the other two directives; in doing so, he asks the recipient not to be neglectful (again). It seems that the sender has no other way to contact his collaborator except by correspondence; this is also the case for his collaborator (cf. ll. 10-12).

The main body of the second example, *SB* VI 9026 (ll. 3-19) contains two directives (one basic and one subsidiary) related to the sending of *kroke*. This textual unit (ll. 10-15) is structured as follows:

directive$_1$: πά[ν]τῃ πάντως μοι **πέμψῃς** τῷ ἀγωγίῳ | τούτῳ ἐριοξύλου δραχμὰς εἴκοσι σπουδαίας κρό|κης (ll. 10-12)[44]

directive$_2$ (*repetition*$_1$): ἀλλ᾽ **ὅρα μὴ ἀμελήσῃς** (l. 12)[45]

supplement$_{1, 2}$: ἐπεὶ οἱ ἀδελφοί σου ἐπεν|δύτην οὐκ ἔχουσι ἐκτριβέντων τῶν ἐριοξύ|λων αὐτῶν, καὶ χρείαν ἔχουσι ὡς οἶδας καθὰ | πάντοτε ἐν ἀγρῷ διατρ{ε}ίβουσι (ll. 12-15)[46]

The female sender of this request letter asks for twenty drachmas of *kroke* of high quality cotton. Her letter is written in a rather imperative style. There are two imperative tone markers, namely a. the pleonastic adverbial phrase consisting of two deontic markers πά[ν]τῃ πάντως ("by all means"; l. 10), and b. the use of the commonplace, stereotypical directive ἀλλ᾽ **ὅρα μὴ ἀμελήσῃς** (l. 12), which emphasises the necessity to satisfy the basic request. The reason for the sender's worry is mentioned in the lines that function as supplements to the two directives; the recipient's brothers' outer garments are worn out, and new ones are needed for their everyday activities in the fields.[47] The verb οὐκ ἔχουσι, the participle ἐκτριβέντων, and the verbal phrase χρείαν ἔχουσι point to an urgency. The present request letter is the only means available to this woman, who is probably a professional,[48] to solve the practical difficulty she encounters.

Conclusions – further discussion

The speech act of requesting is fundamental in textile production. Being the only means of written communication, request papyrus letters form a part of every aspect of textile production and use in late antique Egypt. The ancient writers asked — sometimes in an intense, if not desperate, manner — for materials, products, money, ideas or solutions to their problems. The heterogeneity of these texts

43. "Siehe zu, dass du nicht anders handelst"; *ibid*.

44. "By all means send me by this shipment twenty drachmae's worth of good cotton thread"; see Winter & Youtie 1944, p. 258.

45. "See that you do not neglect it …"; *ibid*.

46. "… since your brothers have no outer garments, now that their cotton ones are worn out, and they need them, as you know, inasmuch as they spend all their time in the field"; *ibid*.

47. The verb ἐκτρίβω means "to rub out" or "to wear out" (cf. *LSJ*^{9} *s.v.*), *i.e.* destroy to a large extent. However, the possibility that the garments in question are very worn-out but still usable cannot be excluded. Words like τρίβων or its morphological diminutives τριβώνιον and τριβωνάριον ("worn-out garment, possibly a cloak"), τριβακός ("rubbed", "worn-out"), and ἡμιτριβής/μεσοτριβής/μεσοτριβακός ("half-worn") that also belong to the word family of τρίβω ("to rub", "to wear out") are used in the papyri to denote the rubbed but still usable clothes. What is more, worn-out clothes could be repaired; cf. the participle τεθεραπευμένη (mended < θεραπεύω) attested in another request letter, *P. Oxy.* XLII 3060, 2–4 with BL VIII 265 (2nd century AD): ἐκομι[σά]μην ἐφίπ̣π̣[ια?] παρὰ Σ̣αραπᾶτος καὶ | σύνθε̣[σι]ν σπανὴν ἡ[μιτ]ριβῆ{ν} [τεθ]εραπευμένην | καὶ ἐπικ[ά]ρσιον ὁμοίως ἡμιτ̣ρ̣[ιβῆ]{ν} ("I have received a saddle-cloth from Sarapas, and a Spanish outfit, half-worn and repaired, and a striped (?) garment, likewise half-worn"; see edition). On the topics of "wear and tear" and of repairing worn-out clothes, cf. see Bogensperger & Koroli 2018 and Bogensperger & Koroli 2020a. However, the big quantity of *kroke* requested lessens the possibility that the sender is interested in repairing the rubbed garments and rather points to the making of new ones (I would like to thank Ines Bogensperger for our discussion and this remark). A comment on *SB* VI 9026 as a source of information regarding cotton textiles in Antiquity is offered by Bogensperger 2016, p. 261-262.

48. Cf. Bagnall & Cribiore 2006, p. 356.

in both content and style allows us to explore many aspects of the ancient textile industry such as manufacturing, utilizing, transferring and merchandizing. The suggested model of analysis brings to the fore the common features of these letters, which are hidden behind their thematic and stylistic diversity, and therefore allows the examination of the information they contain in a systematic manner. The location of the recurrent rhetorical patterns and linguistic strategies makes possible a more satisfying classification and interpretation of the information available, and allows us to speak of recognizable commonplace tactics used by the people who were involved in textile manufacture and industry.

The presentation of the examples in the last chapter made it clear that in order to take full advantage of these valuable textual sources, the situational framework within which they have been produced must be explored further. First and foremost, the social profile of the correspondents and that of the persons also mentioned in the epistolary text (are they male or female? are they professionals or not?), their relationship (is it personal and/or professional? is there any social, financial and/or business distance between them?), along with the exact involvement of these persons in the mentioned activities should be determined. At the same time, it is necessary to make assumptions with regard to the work place (are the mentioned activities carried out at home and/or at a workshop?). Finally, the exact qualities and function of the mentioned articles (either the materials, the tools and the samples or the fabrics as finished products), the nature and purpose of the mentioned activities should be worked out. The combination of this intratextual information about the situational context with textile and financial history sheds light on the broader, cultural context of the letters under study.

Furthermore, the wealth of information contained in request letters should be combined with that attested in other kinds of documentary papyri (*e.g.* the *logoi himation*, *i.e.* the long inventories of fabrics with prices and/or other specifications) or semi-literary papyri, as well as the information furnished by Greek late antique and Byzantine literature. Etymological analysis is also particularly helpful for understanding puzzling terminology. Finally, a joint examination of the textual findings together with the archaeological evidence, *i.e.* the textiles excavated in Egypt, would definitely enable us to reach more solid conclusions on the topic of requesting.

However, such a synthetic analysis of the whole corpus of request papyrus letters remains a *desideratum* for both papyrologists and textile researchers.[49]

Abbreviations

All papyrological works and all references to papyri, ostraca, etc. follow J.F. Oates, R.S. Bagnall, S.J. Clackson, A.A. O'Brien, J.D. Sosin, T.G. Wilfong & K.A. Worp (eds.), *Checklist of Greek, Latin, Demotic and Coptic Papyri, Ostraca and Tablets*. Available at: https://library.duke.edu/rubenstein/scriptorium/papyrus/texts/clist_papyri.html (continually updated)

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49. For an example of a multi-faceted analysis of a 2nd-century private request letter, see Bogensperger & Koroli 2019b on the meaning of the term *entype* in the private request letter *P. Giss.Apoll.* 20.

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Table: Thematic diversity in the objects of the requests related to fabrics

giving/sending or receiving	a) fabrics as finished products	*e.g. O.Claud.* I 177.2–5 (2nd century AD): **κόμισαι** παρὰ | Κωλ τὸν ἀμαξέα τὴν λώδι|καν καὶ ⟦κ( )⟧ \κι/θώνιν (l. χιτώνιον) καὶ πάλ|λιν.[50]
	b) goods to be used for the manufacturing of fabrics, *i.e.* raw materials, dyes, tools, samples, etc.	*e.g. P.Berl.Zill.* 11.16–19 (3rd century AD): **πέμψον** διὰ τῶν κτηνῶν | ἃ εἶπον σοι μνᾶς δύο πορφύρας καὶ τὴν πορφύ|ραν τῶν ἱματίων, καὶ ὁμοίως **πέμψον** Ἡρα|κλείδῃ πορφύρας μνᾶς (l. μνᾶν) α μεγάλων κύκλων;[51] *P. Kellis* I 71, 48 with BL XII 94 (mid-4th century AD): **ἀξιῶ δέξαι** παρὰ Καμὲ τοὺς δέκα στατῆρας στήμονος καὶ **δὸς** Ψάι{ς} Τρυφάνους.[52]
	c) money (selling or buying of finished products, materials and/or dyes or payment for services)	*e.g. BGU* III 948, 18-20 with BL VI 13-14 (4th–5th century AD): **θέλησον** [ο]ὖν υἱέ μου Θεόδουλε **ἀγοράσ<ε>ιν** | μοι ⸌ς⸍ λί(τρας) ἐριδίου μέλα[νο]ς, ἵνα (l. ἵνα) ποιήσω <ἐ>μα<υ>τῇ μαφό|ριον καὶ ἀποστελῶ [σο]ι τὸ κέρμα ὅσου αὐτὰ ἀγορᾷ.[53]
	d) written texts (mostly letters)	*e.g. P. Oxy.* XLII 3057, 22-24 (1st/2nd century AD; see HGV): τὰ ἔρια ἂν ᾖς εἰλη|φὼς παρὰ Σαλβίου πλήρη καὶ ᾖ σοι ἀρεσ|τά, **ἀντίγραψόν** μοι.[54]
	e) people (professionals or not)	*e.g. P. Oxy.* LIX 3991, 13-18 (2nd/3rd century AD): τὸν χιτῶνά σοι τὸν | ἐριό[ξ]υλον ἡ μήτηρ | σου κ[α]τεσκεύασε. | **ἐζητ[ο]ῦμεν** ⟦σοι⟧ τὸν | δυνάμενον κομίσαι | ἀσφαλῆ{ν}.[55]
other activities	a) tasks related to the process of manufacturing	*e.g. P. Oxy.* VII 1069, 23-28 (3rd century AD): **σπούδα|σον** γὰρ τὸ κ{ε}ιθών{ε}ιν μου | γενέστε (l. γενέσθαι) πρὸ<ς> λόγον, καὶ κ[α]|λὰ μέτρα αὐτῷ **βαλέτωσαν** | καὶ μεγάλε (l. μεγάλαι?) **ἔστωσαν** ἐπ{ε}ὶ | ῥείδης (l. ῥίζης) αὐτοῦ.[56]
	b) activities related to already made fabrics (use, cleaning and conservation, further elaboration), etc.	*e.g. P. Mil.Vogl.* II 77, 13-14 (2nd century AD): τὰ κρόκια καὶ τὰ ἱμάτια **ἐκτίνασ|σε**.[57]
	c) production of oral texts (the sender asks the recipient to provide information, to submit a request or to pose a question to a third person)	*e.g. P. Mich.* III 201, 9-12 (AD 99): καὶ **ἐρω|τήσαται (l. ἐρωτήσατε)** Ἀπίνα (l. Ἀπίωνα?) περὶ τῶν φαιν|ωλῶν (l. φαινολῶν), καὶ **ἐρωτήσαται (l. ἐρωτήσατε)** αὐτὸν (l. αὐτὸν) ὅ|τι πόσον δαπανήσουσιν ὕφανδρα (l. ὕφαντρα).[58]

50. “Receive from the wagoner Kol the blanket and a *chiton* and a *pallium*”; see edition.
51. “Sende mit den Lasttieren was ich Dir gesagt gabe, zwei Minen Purpur and den Purpur für die Mäntel, und sende ebenfalls dem Herakleides eine Mine Purpur für grosse Binden”; see edition.
52. “Please get ten staters of thread from Kame and give them to Psais, the son of Tryphanes”; see edition.
53. “Please then, my son Theodoulos, buy for me 6 pounds of black wool, so that I may make a hooded cloak for myself, and I will send you the money for the money you spend on it”; see Bagnall & Cribiore 2006, p. 224.
54. “If you’ve received the wool from Salvius to the full amount, and if it’s satisfactory, write back to me”; see edition.
55. “Your mother made you the cotton tunic. We were looking for someone reliable who could deliver it”; see edition, as well as Bagnall & Cribiore 2006, p. 355.
56. “Be careful to have my tunic made properly, and let them put good measure into it, and be large-handed in the colouring”; see edition.
57. “Shake out the woollen cloths and the cloths”; see Bagnall & Cribiore 2006, p. 186.
58. “And ask Apion about the cloaks, and ask him: ‘How much will the cost of weaving be?’”; see edition; cf. White 1986, p. 156.

How (not) to organise Roman textile production. Some considerations on merchant-entrepreneurs in Roman Egypt and the ἰστωνάρχης

Kerstin Droß-Krüpe

Preliminary remarks[1]

For almost the last 100 years, various ancient historians have suggested that organisations comparable to the "putting-out" system existed in the Roman Imperial period. They are most commonly believed to have occurred in textile production. As early as 1913, Theodor Reil assumed that the production of textiles in Roman Egypt was organised through the putting-out system.[2] This idea can subsequently be traced through more than a century to recent publications.[3] However, as this assumption is rarely based on genuine source material, it seems appropriate to get to the bottom of this hypothesis. In this context, special attention will also have to be paid to the question of large textile companies and the professional title of ἰστωνάρχης, which has been associated with the putting-out system in the past.

Putting-out system and merchant-entrepreneurs

In order to avoid terminological blurring, let us briefly outline what is understood in economic history and modern economics by the term "putting-out system". This term is used to describe a form of economic organisation that is mainly typical of modern textile production, in which craftsmen who are not independent produce goods at home. A merchant-entrepreneur provides the resources and/or raw materials. He is also the one who collects the goods after completion and markets them centrally.[4] This production system was particularly frequent in the production of bulk goods, which were in high demand and could be produced in a decentralised manner without either complex technical equipment or costly investments in the necessary production material. The skills required in the putting-out system were usually low. Work in the putting-out system was especially common in rural areas, where only narrow agricultural yields could be achieved and where it was an important additional income for poorer farming families. While wages were often very small, they were available in those phases of the year when there was no work on the fields.

The depressed living conditions endured by most of those employed in the system are illustrated by Thomas Hood's poem *The Song of the Shirt* from 1843. Another condition for the putting-out system to exist was for labour to be paid as piecework, since working at home made the monitoring of time impossible. From the point of view of economic rationality, the advantages of this kind of

Published in Maria Mossakowska-Gaubert, ed., *Egyptian Textiles and Their Production: 'Word' and 'Object' (Hellenistic, Roman and Byzantine Periods)* (Lincoln, NE: Zea Books, 2020). doi 10.32873/unl.dc.zea.1089

1. My thanks go to Stefanie Hoss for helping with the English version of this paper.

2. Reil 1913, p. 108; followed by Wipszycka 1966, p. 2.

3. Wierschowski 1993, p. 127; Vicari 2001, p. 88 and note 14; Drexhage *et al.* 2002, p. 111 and 132; Kehoe 2007, p. 566; Gibbs 2012, p. 42–43.

4. The putting-out-system is not, however, a modern development, but already appears occasionally in the medieval period, see Bettger 1985, p. 1675. For the basics on the putting-out system, see Holbach 1994, esp. p. 26–38.

production are obvious: a large number of products could be produced according to season or demand without the necessity of having central workshops, and especially without the investments connected with their construction. Central to this is the separation of capital and labour characteristic of a capitalist system: the merchant-entrepreneur bears the entire financial risk, since he has to lay out his capital in order to procure the materials and work equipment and pay the workers, before trying to sell the products they have produced on the market. However, he also has the exclusive and unrestricted right to dispose of the work products. Resulting from this, he also has a decisive influence on the production process and he determines production output and workforce wages. Another premise for this decentralised way of manufacturing goods is that the putting-out system is advantageous only as long as the production processes were short and did not require a division of labour.[5]

In this paper, we will begin by exploring the genesis of the idea of a Roman putting-out system in Classical scholarship, before the individual characteristics of publications about textile industry (briefly outlined above) are compared with the available ancient sources on the Roman textile economy of the Imperial period. For this, the papyri from Egypt are of central importance. They provide a particularly good impression of the complex conditions of the Roman textile industry, since many thousands of documents have been preserved from the province of Egypt, which offer more insights into the ancient realities of normal everyday life than any other source. From contracts, letters, receipts, petitions and the like we get an almost voyeuristic view into the economic, social and legal realities in this province, and thanks to these texts we are informed much better about Egypt than all other regions of the Imperium Romanum or the rest of the ancient Mediterranean world.[6]

On the genesis of an idea

When Reil first advanced the thesis of a putting-out system in the textile production of Roman Egypt, he relied mainly on the papyrus *P. Haw.* 208.[7] He interpreted this document, found in a necropolis of the Fayum and dated to the year AD 24/25, as the inventory of a merchant-entrepreneur.[8] In his opinion – and here he follows the *editio princeps* – the papyrus lists the products delivered to the merchant-entrepreneur, the amounts and the name of the supplying weaver. He returned to his idea of the putting-out system in his interpretation of the professional title ἱστωνάρχης.[9] Mikhail M. Khvostov also relied on *P. Haw.* 208 and Reil's interpretation of it to support the idea of the putting-out system for the Roman textile industry, and more than 50 years later, Ewa Wipszycka followed him in this.[10] Although Khvostov acknowledges that there is no unequivocal evidence of the existence of intermediaries for the Roman period, he believes that the transfer of these economic processes – established with certainty for other periods – into the Roman period is legitimate.[11] Wipszycka cannot avoid referring to the lack of evidence from the Roman period on the question of the economic (in)dependence of weavers. In her view the idea of merchant-entrepreneurs is also supported by *P. Oxy.* XIV 1737. This document is a list of goods and prices, and lists the lease of a loom in addition to garments. For Wipszycka, this document is the ledger of a merchant-entrepreneur, who "a noté les pièces de vêtement au fur et à mesure qu'il les recevait, marquant la date de chaque livraison".[12] Scholars in both papyrological research as well as ancient history have followed this interpretation almost without exception.[13]

However, Peter van Minnen was able to demonstrate convincingly that *P. Haw.* 208 is a register of customs duties, which excludes this document as proof of the existence

5. Hansmann 2006, p. 18.

6. The opinion that the circumstances reconstructed from Egypt cannot be transferred to other provinces because Egypt is a 'special case' has been frequently expressed in the past, stubbornly ignoring the finds and the information from documentary papyri (*e.g.* Sommer 2013). However, Rostovtzeff (1955/1998, Vol. 1, p. 200–201) has stated that the information from Egypt is not only extremely reliable, but also perfectly agrees with the, albeit sparser, finds from other parts of the Empire, which has been confirmed by later research (*e.g.* Braunert 2000, Droß-Krüpe 2011, Reinard 2016, esp. p. 947–1002).

7. With BL IX, p. 8 and BL X, p. 234. After P. van Minnen re-examined the document, the text is now known as *SB* XX 15189 (van Minnen 1992, p. 205–208).

8. Reil 1913, p. 108 note 6.

9. *Ibid.*, p. 108, for more details see below.

10. Khvostov 1914, p. 176; Wipszycka 1965, p. 99.

11. Khvostov 1914, p. 176.

12. Wipszycka 1965, p. 99. She further elaborates, "Tout cela peut nous donner une idée des opération qu'exécutait un intermédiaire (celui qui a dressé le compte ou celui à qui ce compte était destiné). C'était un homme d'affaires ayant des relations avec de nombreux artisans qui lui fournissaient des vêtements faits contre rémunération en espèces."

13. See the literature listed in note 2.

of a putting-out system in weaving.[14] The interpretation of *P. Oxy.* XIV 1737 is also subject to uncertainties. Many of the abbreviations used in this papyrus are difficult to resolve, with several readings possible for each of them, making the correct interpretation of the text very difficult. The structure of *P. Haw.* 208 corresponds to *P. Oxy.* XIV 1737 and in my opinion points to it being a private settlement, as is known from countless other examples.[15] It is therefore conceivable that the author of this document lists his private expenses here and did not, as Wipszycka supposes, receive the listed items for the price named from third parties. The details of the lease for the loom are also not clear; it must remain open, whether this is expenditure or revenue to be registered.

Since both *P. Haw.* 208 and *P. Oxy.* XIV 1737 cannot be used as evidence, or are at least very doubtful proof of the existence of an ancient putting-out system in the Roman textile industry of the province of Egypt, the characteristics of this production method (as outlined above) will now be compared to the available source material. These characteristics include: low specialisation and qualification; external acquisition of the necessary raw materials; external marketing / distribution of the manufactured products; a high degree of standardisation; economic dependence of the craftsman on a merchant-entrepreneur; and payment on the basis of finished pieces instead of working hours.

Specialisation and qualification

Looking first at the premise of a relatively small degree of specialisation, it soon becomes clear that this is not true for the textile economy of the Roman Empire, which was characterised by a strong professional specialisation and a high degree of division of labour.[16]

The papyri of the province of Egypt alone document 27 different professions and job descriptions for the production of textiles and garments from the 1st to 3rd centuries AD. If we add the epigraphic record, then 113 groups of textile craftsmen can be found in Greek-language records alone.[17] The spectrum of documented fields of employment in this economic sector ranges from the basic and unspecified work steps of dyeing, weaving and fulling textiles to the highly specific purple dyers (πορφυροβάφος), linen weavers (λινόϋφος / λίνυφος) and wool washers (ἐριοπλύτης). The specialisations relate to specific raw materials on the one hand and to specific textiles (*e.g.* carpet weavers, ταπιδυφάντης, or weavers of Tarsian garments, ταρσικάριος) on the other. So, Roman textile production can by no means be described as an economic sector with a low degree of specialisation; on the contrary, professional specialisations are very pronounced. These are no good prerequisites for the establishment of a putting-out system. Moreover, the skills and abilities required of the craftsmen involved in textile manufacture cannot be considered as negligible. On the contrary, the archaeological finds demonstrate that many of the textiles produced in this region were manufactured with great skill.[18]

External acquisition of the necessary raw materials and external marketing/distribution of the manufactured products

Some indications of how the acquisition of raw materials in the Roman textile economy was managed can be gained from the papyri. Interestingly, different mechanisms can be identified: *P. Berl.Zill.* 9, a private letter from the year AD 68, indicates that the weaver Satabous has failed to pick up the threads for the textile to be produced. So, here it is the textile craftsman who is responsible for obtaining the necessary materials. However, it has been documented more frequently that it is the customer, *i.e.* the person commissioning the production of a fabric, who furnishes the textile craftsmen with their raw materials. Both the yarns and the dyes are procured by the clients themselves.[19]

14. van Minnen 1992.
15. For this type of text, see Bandi 1937, p. 348–451.
16. See Droß-Krüpe 2011, p. 47–102.
17. Ruffing 2008, p. 113–114. In this list, the female forms of professions also known for men have not been counted separately and professions that appear in two production groups have been counted only once. H. von Petrikovits has listed 27 Latin professions in the textile production from epigraphic and literary sources dating from Diocletian onwards (von Petrikovits 1981, p. 295–306).
18. See, for instance, Kendrick 1920 or Stauffer 1995 as examples for many other publications.
19. Purple is sent in: *P. Mert*. III 114 (with BL XI, p. 130, late 2nd century AD, Arsinoites); *P. Bingen* 74 (post-AD 130, Alexandria?); *P. Oxy.* VI 931 (2nd century AD, Oxyrhynchus); *P. Berl.Zill.* 11 (3rd century AD, unknown place); *P. Oxy.* XIV 1678 (3rd century AD, Oxyrhynchus); *PSI* IX 1080 (3rd century AD?, Oxyrhynchites); *P. Oxy.* XXXI 2599 (3rd/4th century AD?, Oxyrhynchites); *SB* XXIV 16269 (3rd/4th century AD, unknown place); *O. Florida* 16 (second half of 2nd century AD; Thebais); *P. Oxy*. XXXIII 2679 (2nd century AD, Oxyrhynchites); *P. Oxy.* XX 2273 (late 3rd century AD; Hermopolites?). It often cannot be decided whether the text deals with the colouring agent, coloured thread or a complete textile, especially when the amounts are missing.

A noteworthy text in many respects is the letter *SB* VI 9025, sent by Heraclides from one of the small oases to a certain Horion in Oxyrhynchus in the 2nd century AD.[20] The two writers evidently exchange both letters and commodities frequently; cereals, olive oil, legumes, olives and various fruits are the subject of their correspondence, and various messengers are involved in the transfer of the goods. Textiles and textile raw materials are also mentioned in the postscript of the letter. Herakleides was supposed to have procured for Horion a piece of clothing made of cotton (τὸν χιτῶνα τὸν ἐρεόξυλον), which he did not manage because of the haste required (the reason for which is unknown). However, he makes a suggestion to Horion: he could commission the weaving of a *chiton* instead, but then he would need to send the warp threads and measurements (στήμονα καὶ τὰ μέτρα). This is a proposal to produce a garment needed in the metropolis of Oxyrhynchus in an oasis a few days' journey away to the west of the Nile!

Another private letter of unknown origin, probably from the 2nd or 3rd century AD also records the request to send weft threads (κρόκη), which are needed for the weaver to start his work.[21] Something similar appears in *P. Mert*. III 114 from the Arsinoite nome.[22] The author of this letter, a certain Achillas, orders a garment for himself from Sarapias and Thermuthis. The necessary threads for warp and weft come from different sources; while the women apparently made the wefts themselves, Achillas has acquired the warp threads elsewhere and now sends them to the women together with purple dye (πορφύρα) for the garment to be produced.

None of the preserved papyri provides evidence of a person procuring raw materials to make garments for third parties or that the textiles produced from these raw materials would be sold to third parties after their completion. Although an external acquisition of raw materials can indeed be established, the supplier is always the customer or his personally known middleman, and never a professional intermediary or merchant-entrepreneur.[23]

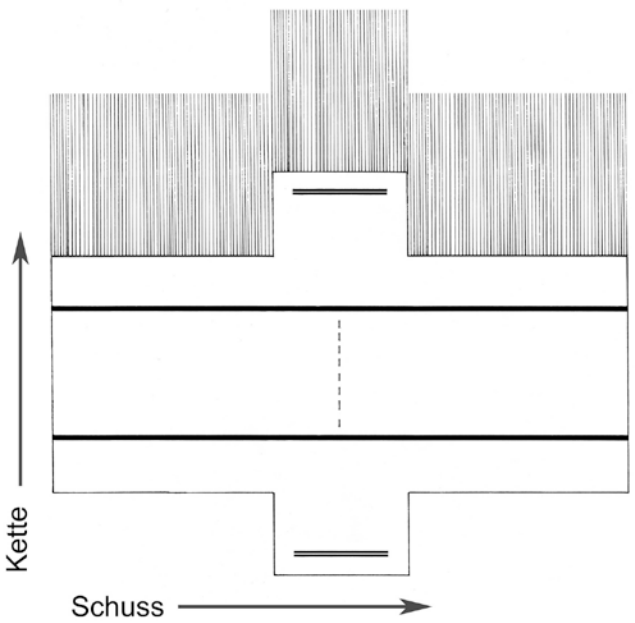

Figure 1. Sketch of a tunic, woven to shape on a Roman two-beam vertical loom. (Drawing © Barbara Köstner).

High degree of standardisation

Another characteristic of the putting-out system, standardisation of the manufactured products, can also be questioned with regard to the textile production of the Roman Empire. Again, it is mainly the papyri that offer insights here. A papyrus in which measurements (τὰ μέτρα, *SB* VI 9025) for the garment to be produced are requested has already been mentioned above. This is an exception; in general orders for garments contain no measurements.

However, this does not mean that only quite uniform standard dimensions were produced. The archaeological finds clearly show varying lengths and widths in the preserved tunics.[24] During weaving, the warp is laid out; accordingly the tunics were usually woven in one piece and not usually tailored from several parts and adapted to the wearer like later garments.[25] The size of the finished textile

See also Worp 1997 and Bogensperger 2017. Raw wool is sent in *P. Turner* 18 (AD 89–96?, unknown place; for the date, see Hagedorn 2001, p. 159).

20. Bagnall 2008; Reinard 2016, p. 912–919.

21. *SB* XIV 12011. For the date, see de Wit 1978, p. 81. Weft threads are sent as well in *P. Berl.Zill.* 9 (AD 68, place unknown) and *P. Oxy.* XXXI 2593 (2nd century AD, Oxyrhynchus).

22. Late 2nd century AD (with BL XI, p. 130); Messeri Savorelli 1995, p. 129–133.

23. See also Droß-Krüpe 2011, p. 173–174 and 206–207; Reinard 2016, p. 465–479; Droß-Krüpe 2019.

24. For a compilation, see Droß-Krüpe 2012b, p. 100.

25. Occasional Roman textile finds from Israel, Jordan and Egypt (*e.g.* Yadin 1963, p. 204–219; Cardon 2003, p. 642 and 654, fig. 336 [Z 22030–6], Huber 2013) as well as some depictions on mummy portraits from Graeco-Roman Egypt (British Museum, London, EA63397, early 2nd century AD; Kunsthistorisches Museum, Vienna, Antikensammlung X 303, AD 125–150;

was thus determined during weaving. The tunic could later be shortened by sewing a waist tuck or a hem. Occasionally some decorative parts could be made as an extra and applied subsequently.[26] Since the preserved tunics have significantly differing measurements, the approximate size of the future wearer seems to have been known to the weaver. This assumption is supported by the papyri, which show close personal relationships between client and weaver or dyer.[27] The papyrus noted above (*SB* VI 9025) is thus proof that measurements were only necessary in the case of a client who, like Horion, lives in another city and is unknown to the weaver.

Standard sizes would be most likely for orders of textiles from the government. *BGU* VII 1564, an order for textiles for the military, is the only text that lists precise measurements. The order contains:

- 1 white *chiton* (χιθὼν [= χιτὼν] λευκὸς ζωστὸς εἷς), belted, 3 ½ ells long, 3 ells and 4 daktyls wide, weighing 3 ¾ mines,
- 4 white Syrian cloaks (συρὶαι λευκαὶ τέσσαρες), each 6 ells long, 4 ells wide, weighing 3 ¾ mines,
- 1 white blanket (λῶδιξ λευκὸς εἷς), plain weave, 6 ells long, 4 ells wide, weighing 4 mines.

In my opinion the fact that a government order for soldiers is the only list of exact dimensions for garments to be found indicates that this information was absolutely necessary to prevent the delivery of textiles of the "wrong size". An explanation for this unusual specification would be in the absence of a close personal relationship between client and producer in the case of government contracts.

It can thus be noted that a formal standardisation in Roman textile production cannot be established. Although there were master patterns that served as a design aid to weavers and fullers, and colour samples could also be sent,[28] according to the papyri, garments were usually bespoke with the colour and material controlled by the customer.[29]

Economic dependence and remuneration

There is no doubt that in Roman antiquity all artisans were dependant on their clients, but this condition is by no means limited to the pre-modern era. Nonetheless, indications that (textile) craftsmen would only produce for a single customer are completely absent. They apparently exercised their craft for various different clients and in their small and micro-enterprises they also engaged apprentices and employees.[30]

They were obliged by the Roman government, which, as briefly mentioned above, could also appear as a client, to pay a trade tax, the χειρωνάξιον.[31] This was paid *per capita*, but it differed in amount depending on the locality, gender and social status of the craftsman. The taxation of craftsmen is a strong indication of their professionalism and independence. There are many cases of garment orders by letter, although these letters do not clearly differentiate between business and private correspondence.[32] It is not always possible to decide whether the garment ordered will be made in the household of one of the letter writers or in an external workshop. According to the known sources, however, no document speaks about the supply of a larger

Medelhavsmuseet Stockholm, NM Ant 2307–2309, undated) and hints in the literary sources (Varro, ling. 9,79 and Suet. *Aug*. 94) demonstrate that sleeveless tunics could alternatively be designed by using two identical loom pieces seamed together across the shoulders after having been taken off the loom; see Granger Taylor 1982. However woven-to-shape tunics can be detected until the 7th century AD; see also Pritchard 2006, p. 45, Mossakowska-Gaubert 2017, p. 321–322. I am very thankful to Barbara Köstner for generously sharing her knowledge about weaving tunics and for providing me with detailed references about the scattered evidence for tunics made of two pieces.

26. Paetz gen. Schieck 2002, p. 32–34.

27. Reinard 2016, p. 465–479; Droß-Krüpe 2016, p. 66–68.

28. Stauffer 2008, p. 11–12; Droß-Krüpe 2011, p. 159; Bogensperger 2016, p. 262–266.

29. Here the question arises as to how we should interpret the trading of large amounts of textiles. For example, *SB* XVIII 13167 (2nd century AD) documents the importation of significant quantities of cloth from India. In addition, *graffiti* from Dura Europos illustrate that there was a significant trade in clothing under the auspices of Nebuchelos (*SB* XVIII 13167); Thür 1987, p. 229–245 and Thür 1988, p. 229–233, for Nebuchelos, see also Ruffing 2000, p. 82–90. Trading of a large amount of textiles across a customs border is also shown from *P. Oxy.Hel.* 40 (see Droß-Krüpe 2011, p. 78–86 with further literature). In all of these cases, however, the exact sequence from the order to the delivery of the textiles cannot be clarified. However, one thing can be stated with certainty: none of the texts provides any indication of the appearance of persons who act like merchant-entrepreneurs.

30. Droß-Krüpe 2011, p. 201–202.

31. Wallace 1938, p. 193–202; Reiter 2004, p. 111–144; Droß-Krüpe 2011, p. 193–196; Droß-Krüpe 2012a, p. 215–226.

32. See Reinard 2016, p. 57–126.

number of finished textiles, as would be expected for the putting-out system. Where the payment of wages is documented, however, it is always a price per unit, never per working hour.[33]

Merchant-entrepreneurs outside of Egypt

Scholars have presumed the textile trade to be organised according to the putting-out system in other regions of the Roman Empire as well. John F. Drinkwater assumes the existence of merchant-entrepreneurs in the textile economy in the regions of Germania and Gaul.[34] He looks at the depictions on the so-called Igel column, a Roman tomb from the middle of the 3rd century AD in the village of Igel on the Moselle near Mainz. Drinkwater interprets the scenes from the textile industry depicted on the column as documenting the actions of a merchant-entrepreneur. He understands the Secundinii family from Igel, who had this tomb erected, to be textile merchant-entrepreneurs, who "die Rohmaterialien besorgten, die Herstellung des Garns und des Tuchs kontrollierten und überwachten und vor allem, […] dafür sorgten, dass das Endprodukt bereitstehende Käufer fand".[35] He bases this assumption on a diachronic comparison with the wool industry in Flanders, England and Italy between the 13th and 17th centuries. However, the transfer of the complex organisational processes of this medieval and early modern industry to Roman antiquity without the support of contemporaneous sources is methodologically problematic. As has been shown above, none of the characteristics of the putting-out system appear in the documentary tradition in relation to the ancient textile industry.

On the contrary, both the papyri as well as in the archaeological finds for this economic sector attest to the existence of independent (small to medium size) producers.[36] Also, it cannot be indicated that the means of production were not the property of the respective producers in most cases.[37] The traditional interpretation of the Igel column, which regards the Secundinii as cloth merchants, is more likely to be true of the ancient conditions, even if they may have integrated earlier production steps into their value chain in the sense of a vertical integration.[38]

In the end, none of the conditions formulated in the beginning for the development of a putting-out system could be could be found in the ancient sources on textile production. The often-repeated hypothesis that the production of textiles was organised within the putting-out system in Egypt and other regions of the Imperium Romanum, a system that had been widespread in the late Middle Ages and the early modern period in this sector, cannot be substantiated by the source material. Rather, it seems that the well-known putting-out system of the European textile industry between the mid-15th and the last third of the 19th century has been projected onto ancient conditions.[39] Reil, in whose work, as far as I can see, this hypothesis first appears, may have been familiar with this economic organisational form himself.[40] It cannot be ruled out that conditions from his own experience, or mechanisms that were

33. Droß-Krüpe 2011, p. 207–214.

34. Drinkwater 1977/1978, p. 107–125; Drinkwater 1978, p. 817–850; Drinkwater 1981, p. 215–233. In his latest paper on this subject (Drinkwater p. 2001, 297–308) he reconsiders some of the hypothesis suggested in these publications, but remains convinced that the Secundinii were merchant-entrepreneurs: "[…] they produced these fabrics in and around Trier, by recruiting and orchestrating a large and specialised, and therefore highly dependent workforce, of spinners, weavers, fuller, dyers etc., paid by the piece." [298]

35. Drinkwater 1977/1978, p. 110.

36. See Drexhage *et al.* 2000, p. 103 and 108; Droß-Krüpe 2011, p. 151 and 188–189; Flohr 2014, p. 10.

37. The use of slaves appears to have played a minor role in ancient craft production. In some production sites, such as Arezzo, they were used in greater numbers in the production of *terra sigillata*, while slaves were hired only occasionally and for a limited time for (supplementary) work in La Graufesenque in southern Gaul. For Arezzo, see Delplace 1978, p. 55–76 and Prachner 1980; for La Graufesenque, Grenier 1938, p. 84–89 and Kiechle 1969, p. 78–81 and 90–94. For the low importance of slave work in Roman Egypt, see Ruffing 2013, p. 199–210.

38. According to (among others) Drexel 1920, p. 83–143 and Zahn 1982. Also see Broekaert 2014.

39. The putting-out system was not limited to textile production, even though it was strongest in this field of production, but was also found in metal ware, watch and woodwork production. See Sombart & Meerwarth 1923, p. 185–189.

40. Theodor Reil, born in Dresden in 1889 the son of a teacher and later school councillor, did not come from the agricultural or craft milieu himself, but the structures of the dominant merchant-entrepreneurs in his home region were very widely known at this time. Cautious estimates show that almost half of all industrial workers were active in this form of economic organisation in Germany at the beginning of the 19th century, with the number of people working from home even increasing in subsequent years. See Pierenkemper 1994, p. 15. For Reil himself, see his CV attached to his dissertation (Universitätsarchiv Leipzig, PhilFakProm08279).

common in his time could have influenced his interpretation of the ancient texts.[41]

Excursus: the archive of Apollonius and the ἱστωνάρχης Chairemon

In addition to the putting-out system, production of textiles in large companies with a large number of dependent employees is also postulated for Roman Egypt, a hypothesis that relies heavily on the documents of the so-called Apollonius Archive. Apollonius, usually the recipient of the letters in this archive, which concerns both private and business matters, was *strategos* in the Apollonopolites Heptakomias *nomos* between AD 113/114 and 120.[42] His family, which can be traced for five generations through documents of the archive, was based in the Hermopolites and owned large tracts of land there, which extended up the Nile into Lycopolites, the neighbouring nome to Hermopolites[43]. Weaving was also practiced on the estates of the *strategos*, and many letters on the subject of textile production were found in the archive.[44] According to Wipszycka, the workshop of Apollonius is a prime example of a large Egyptian weaving mill.[45]

In one of the letters of this archive, Chairemon, who calls himself ἱστωνάρχης and is at the estate of Apollonius, corresponds with the *strategos*. Apollonius, as we learn from *P. Giss.* I 12, had already sent Chairemon warp and weft threads from which coats were to be made.[46] Chairemon now asks him to send an ἐντύπη, presumably a true-to-scale pattern drawing for the tapestry design to be incorporated into the textile.[47] The use of such patterns on the estate of Apollonius makes it clear that elaborate textiles made to customer specifications were produced here. As Annemarie Stauffer rightly points out, this weaving technique is particularly labour-intensive work that takes a long time and is therefore not economically efficient. The goal here can never be the rapid production of many textiles, as one would expect in an export-oriented weaving mill, but rather a focus on one complex bespoke individual piece.[48] As already mentioned, Chairemon refers to himself as a ἱστωνάρχης in *P. Giss*. I 12. This uncertain term appears in a group of Imperial papyri, which are mostly about the permission to weave robes that one (γέρδιος) ἱστωνάρχης allows or denies.[49] These permits are issued to persons who are not explicitly named as weavers: in one case another profession is even mentioned explicitly.[50] Ulrich Wilcken interprets the ἱστωνάρχης as "head of the weaving rooms",[51] however, this interpretation does not quite fit with papyrus *BGU* III 753, where a total of 3,670 drachmas of taxes are confiscated for the ἱστωναρχι(κόν). With reference to *BGU* III 753, Walter Otto suggested that said tax should be understood as income tax calculated in parallel to the χειρωνάξιον on the basis of the income of a weaver, a thesis that was not generally

41. This form of organisation, while possible for other crafts (especially where mass production is possible) has not been verified anywhere in the ancient world, see Droß-Krüpe 2012b, p. 206–212.

42. Apollonius was the writer of only three of the letters, namely *P. Brem.* 3; *P. Brem.* 4 and *P. Giss.* I 41. For the office of *strategos*, see Oertel 1917, p. 290–299; Kruse 2002 and Dirscherl 2004.

43. See *P. Brem.* 11, preliminary remarks and the information in *P. Brem.* 20; *P. Brem.* 21 and *P. Giss.* I 10.

44. *P. Giss.* I 12; *P. Giss.* I 20; *P. Giss.* I 21; *P. Giss.* I 68; *P. Giss*. I 78; *P. Brem.* 45 and *P. Brem*. 63. See Wipszycka 1965, p. 81–88 and Kortus 1999, p. 192–193.

45. According to her, a workshop employing more than three or four people is already a "large workshop". Wipszycka 1965, p. 81. E. Kornemann offers a different interpretation in his commentary on *P. Giss.* I 12 (comm. of line 1); he sees the workshop of Apollonius as a "cottage industry", an idea that U. Wilcken picks up in his edition of the Bremer Papyri of the Apollonius archive (comm. to *P. Brem*. 63, p. 7–10).

46. For a reappraisal of the textile production on the estate of Apollonius, see Droß-Krüpe 2011, p. 155–163.

47. Stauffer 2008, p. 11–12.

48. *Op. cit.,* p. 12.

49. The terms ἱστωνάρχης or ἱστωναρχ(ικόν) appear in the following texts: *O. Bodl.* II 1988 (1st to 2nd century AD, Thebes), *WO* 1154 (1st to 4th century AD, Thebes?), *WO* 1155 (1st to 4th century AD, Thebes?), *WO* 1156 (1st to 4th century AD, Thebes), *P. Phil.* 1 (with BL IX, p. 211, after AD 119, Arsinoites), *BGU* XV 2471 (with BL VIII, p. 61, AD 158, Ptolemais Euergetis), *P. Ryl.* II 98 (AD 172, Ptolemais Euergetis), *SB* XXVI 16365 (2nd century AD, place unknown), *O. Wilb.* 75 (with BL VI, p. 214, end of 2nd century AD, Thebes?), *BGU* III 753 (after AD 245, Arsinoites), *P. Oxy.* LXVII 4596 (AD 264, Oxyrhynchus), *O. Bodl.* II 1990 (3rd century AD?, Thebes), *P. Wash.Univ.* I 35 (with BL IX, p. 372 and XI, p. 289, 4th/5th century AD, place unknown); see also Droß-Krüpe 2016.

50. *WO* 1154.

51. *WO* 1154, comm. on line 1.

accepted, especially as income taxes could not be corroborated with other craft workshops with certainty.[52] Reil, on the other hand, considered seeing the ἱστωνάρχης as the head of a larger weaving mill, who probably also practiced this profession himself.[53] As a second possibility, he considered that these persons, possibly in the function of a trader or merchant-entrepreneur, "concentrated" domestic textile production.[54] Axel Persson judged the tax quite differently in view of papyrus *P. Ryl.* II 98, which had then been recently published and had not been available to Wilcken, Otto and Reil. On the basis of the request made in the papyrus by Heron to send 300 drachmas per year for εἰστωναρχίαν in the village of Archelais, he suspects that the ἱστωνάρχης acquired the right from the government to weave in a certain area, and then leased it on to after-tenants [= subcontractors ?]; he sees *BGU* III 753 as the list of lease sums of ἱστωνάρχης.[55] For Sherman Wallace, an ἱστωνάρχης also has the supervision of the looms of a region, a right that is obtained for 300 drachmas a year in *P. Ryl.* II 98. In Thebes (and only there) he also possessed the possibility to issue a permit or a ban on the construction of a loom and thus on weaving.[56] An ostracon of unknown provenance, which was included under the number 16365 in the *Sammelbuch der griechischen Papyrusurkunden* (*SB* XXVI) fits perfectly with these ideas of Persson and Wallace.[57] The document confirms the payment of four drachmas from Tryphon for the month Epeiph. The sum was paid ὑπὲρ ἱστ[ων]άρχου. This seems to be the payment of an individual, namely Tryphon, to the ἱστωνάρχης. In my opinion, the fact that this payment appears to be in monthly instalments, and thus on a regular basis, supports the view of the ἱστωνάρχης as the administrator of a re-leased monopoly on weaving for a particular area. Wipszycka also sees a connection to a monopoly, but interprets the task of an ἱστωνάρχης differently, namely in the granting of permits to "produce textile in one's own household, which was not subject to the χειρωνάξιον, charged only from professional craftsmen. He bought the right to collect fees for the issue of permits from the state on auction (*P. Ryl.* 98); he pays the previously calculated sum into the state treasury (*BGU* 753)".[58] The basis of her hypothesis is the observation that the concessions of the ἱστωνάρχης are usually given to a woman or to a man who has a different profession than that of weaver. In her opinion, the high sum of *BGU* III 753 is explained by the fact that every person who wanted to produce textiles in his own household without exception, first had to obtain the permit of the ἱστωνάρχης and pay for it. Although the preserved documents do not contradict this hypothesis, the question of the feasibility of such an endeavour has to be asked. The compulsory obtainment of permits for the manufacture of textiles for any non-professional weavers, that is for all persons not subject to the χειρωνάξιον, entails the compulsory control of these weaving licenses, a process that would have been quite complicated and that does not show up in our sources. It also is difficult to imagine that every household producing a coat or tunic for itself should be subject to a special levy, as there are no other types of taxation attested for home production: we only have to think of making cheese or slaughtering livestock.

An exception is the brewing of beer and the associated tax of ζυτηρὰ (κατ'ἄνδρα).[59] However, central to the name of this tax is the addition κατ'ἄνδρα, which expressly identifies a tax rate *per capita*. Unlike the ἱστωναρχικόν, the beer tax, which probably had to be paid for the home production of the beverage, is expressly characterised as different from other tax types by this addition.

The multitude of proposed interpretations of the term ἱστωνάρχης clearly shows how difficult it is to grasp. However, the documents allow us to state with certainty that an ἱστωνάρχης can also be a weaver at the same time, and may have employees and can train apprentices.[60] In addition, he grants permits, which allow various persons who are not explicitly named as weavers and in some case are explicitly named as craftsmen of other professions, to weave in any location within a certain district. Different terms are used in the documents, but never explicitly the verb ὑφαίνειν – to weave.

52. Otto 1905, p. 301–302, note 5.

53. Although Wipszycka (1966, p. 16) claims that Reil assumes that the ἱστωνάρχης was therefore also obliged to pay a higher amount of tax, this reference is missing from Reil's own argument. He sees the ἱστωναρχικόν as a business tax, which, also in view of *BGU* III 753, had to be paid by the ἱστωνάρχαι in addition to the normal weaver's tax; see Reil 1913, p. 108.

54. Reil 1913, p. 108.

55. Persson 1923, p. 23–25.

56. Wallace 1938, p. 199.

57. See Nachtergael & Pintaudi 1981, p. 171–173.

58. Wipszycka 1966, p. 18. Wipszycka's interpretation is also used by Kortus 1999, p. 194.

59. See Reiter 2004, p. 145–164.

60. Employees: *BGU* XV 2471 (c. AD 158, Ptolemais Euergetis); apprentices: *P. Oxy.* LXVII 4596 (mid-3rd century AD, Oxyrhynchus).

The relation with the putting-out system postulated by Reil must be refuted, since no proof can be found for this economic organisation in Roman textile economy, at least in Egypt. As unsatisfactory as this may be, a convincing solution for the function of the ἱστωνάρχης cannot be offered here either. He certainly belongs in the context of textile economics, but what exactly his duty was and whether it was just a single, well-defined task cannot be determined with certainty at the moment. However, in spite of the uncertainties outlined, in my opinion the assumption that the ἱστωνάρχης acquired the right from the state to practice professional weaving, expressly not for the household's own consumption, in a given region,[61] then in turn issued licenses[62] for weaving and collected money for them from individuals[63] is perfectly compatible with the documentary evidence. In any case, the fact that Chairemon calls himself an ἱστωνάρχης in his letter to Apollonius does not justify the assumption that Apollonius owned a large weaving mill or that Apollonius' intermediary Chairemon was a kind of merchant entrepreneur.

Conclusion

As the above considerations show, neither the organisational form of the putting-out system nor the production in large, proto-industrial workshops are attested for Roman Egypt and its textile economy. In contrast, small workshops and a system of vertical disintegration dominate, placing the customer, and not an entrepreneur, at the centre.

Abbreviations

All papyrological works and all references to papyri, ostraca, etc. follow J.F. Oates, R.S. Bagnall, S.J. Clackson, A.A. O'Brien, J.D. Sosin, T.G. Wilfong & K.A. Worp (eds.), *Checklist of Greek, Latin, Demotic and Coptic Papyri, Ostraca and Tablets*. Available at: https://library.duke.edu/rubenstein/scriptorium/papyrus/texts/clist_papyri.html (continually updated)

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61. *P. Ryl.* II 98 (AD 172, Ptolemais Euergetis) and *BGU* III 753 (after AD 245, Arsinoites).
62. *O. Bodl.* II 1988, *WO* 1154, *WO* 1155, *WO* 1156, *O. Wilb*. 75 and *O. Bodl.* II 1990.
63. *SB* XXVI 16365.

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Domestic Textile Production in Dakhleh Oasis in the Fourth Century AD

Jennifer Cromwell

Kellis: A Treasure Trove for Textile Studies

Ancient Kellis, modern Ismant el-Kharab is located in Dakhleh Oasis in Egypt's Western Desert. The main occupation of the village was from the early to late Roman period (late 1st century to the beginning of the 5th century AD). Excavated as part of the Dakhleh Oasis Project, the site has revealed textual and archaeological evidence from which a detailed picture of life can be painted. To date, the main publications of the village's finds have focussed on the textual remains, of literary and documentary texts in Coptic, Greek, and Syriac.[1] A comparable publication of the archaeological evidence from the site is still pending, but the context of the surviving evidence is clear.[2] Many of the documents were found in House 3, left there after the abandonment of the village around the turn of the 5th century, and reflect the concerns of several generations of its residents.[3] One reason for the abundance of textual sources is the volume of written communication between individuals in Kellis and others in the Nile Valley, mostly members of the community who had travelled there for a variety of reasons. This Oasis–Valley duality is fundamental to understanding many of the documents, as well as the realities of life for Kellites. The distinction is made

Published in Maria Mossakowska-Gaubert, ed., *Egyptian Textiles and Their Production: 'Word' and 'Object' (Hellenistic, Roman and Byzantine Periods)* (Lincoln, NE: Zea Books, 2020). doi 10.32873/unl.dc.zea.1090

1. To date, eight volumes of texts from Kellis have been published: *O. Kellis* (Greek ostraca), *P. Kellis* I (Greek documentary papyri), *P. Kellis* II (Coptic, Greek, and Syriac literary texts), *P. Kellis* III (the Kellis Isocrates Codex), *P. Kellis* IV (the Kellis Agricultural Account Book), *P. Kellis* V (Coptic documentary texts), *P. Kellis* VI (Coptic, Greek, and Syriac literary texts), and *P. Kellis* VII (Coptic documentary texts).

   Throughout this article, I use these sigla, as included in the *Checklist of Editions of Greek, Latin, Demotic, and Coptic Papyri, Ostraca and Tablets*, updated online at papyri.info/docs/checklist. It should be stressed that many studies on the Kellis material use other sigla, *e.g.*, P. Kell.Copt., as included in the original editions. However, the *Checklist* represents the disciplinary standard and should be used for all discussions of the textual corpus.

   Note that the translations used in this article are primarily those of the original editors, with only minor modifications. Concerning the date of the texts from the site, while some Greek documents date to the end of the 3rd century, the majority of the relevant material dates to the 4th century. The nature of the sources, which predominantly consists of letters, means that individual texts can rarely be dated more precisely than this. As a result of the differential ability to date the sources, I have not provided dates for individual items.

2. Field reports are scattered throughout journals and publications of the Dakhleh Oasis Conference and are too numerous to list here. For philologists, a convenient introduction to the site itself is the substantial overview at the beginning of *P. Kellis* V (the archaeology and numismatic evidence are presented in addition to the contents of the Coptic documents); see also Bowen 2015 and Hope 2015. The recently completed doctoral thesis of Håkon Teigen 2018 and the soon-to-be completed thesis of Mattias Brand, *The Manichaeans of Kellis: Religion, Community, and Everyday Life* (Leiden University) represent significant contributions to the study of life in the village.

3. A plan of Houses 1–3 and their immediate neighbourhood is available in *P. Kellis* V, fig. 1 and online at: http://artsonline.monash.edu.au/ancient-kellis/map/ .

clear through reference to the Oasis (ⲟⲩⲁϩⲉ) and the Valley ("Egypt", ⲕⲏⲙⲉ) and the importance of location will be raised at several points in the following discussion.

The Manichaean nature of the community, for which the texts are the primary evidence, has received the greatest amount of scholarly attention to date.[4] Yet, there is vast potential for the examination of a range of topics, especially in conjunction with the surviving material remains.[5] Examination of the domestic textile industry in Kellis holds particular promise. Possible routes of research include: the use of raw material, equipment (including matching the physical with the textual evidence), production techniques, organisation of work, gendered divisions in labour,[6] the economic value and impact of textiles, local and national networks, and the religious use and role of textiles. Given the restricted scope of the current study, my intention is to provide a snapshot into the world of Kellis textiles and to demonstrate the potential for a complete study of textiles at the village. In order to do so, I look at three different areas:

- The lexical study of textiles, both in Greek and Coptic. Concerning the latter, the Kellis material makes an important contribution in two respects: it significantly expands the chronologic and geographic range of our Coptic evidence, being among our earliest corpora of Coptic documents and located far from the Nile Valley.
- The procurement of raw materials. Wool is used as a case study to highlight the range of evidence available and the different areas of life in the Oasis upon which light is shed.
- The economy of textiles and textile production.

Lexical Goldmine

Within the Coptic texts, both autochthonous and foreign (*i.e.* Greek) words occur—no Coptic words occur as loans within the Greek texts. All attestations of different terms are collected in the appendix at the end of this article. In general, only native words are used for terms connected with the production of textiles and professional matters, while materials and finished products are mostly named using native lexemes. The majority of the lexicon for the textile industry at Kellis, therefore, is Coptic, making the corpus an important addition to the existing body of evidence.

One of the principal problems affecting a clear understanding of the meaning of Coptic terms for textile production, especially garment types, is the nature of the written sources themselves. As Anne Boud'hors and Maximilien Durand noted almost two decades ago:

> "la documentation couvre en effet plusieurs siècles et l'on est toujours incapable d'évaluer une quelconque évolution des modes pour cette période ; les textes témoignent de niveaux de langue très divers, qu'il s'agisse d'œuvres littéraires, homilétiques ou martyrologiques, ou d'extraits de correspondance, de comptabilités, d'actes juridiques ou d'inventaires de biens ; dans de nombreux cas, par ailleurs, on est en peine de dire si les termes employés appartiennent au vocabulaire des tisserands et présentent donc un caractère technique, s'ils relèvent plus de celui des commerçants et abordent les tissus d'un point de vue qualitatif, ou encore s'ils correspondent à une terminologie plus quotidienne et désignent la pièce en fonction de son usage."[7]

Issues exist regarding the scattered nature of the textual sources, chronologically and in terms of textual genre (to which one should also note the geographic component, as there may be no terminological consistency between such distant regions as the Fayum and western Thebes), and whether terms were part of the common vernacular or of the specialist language of different groups involved with textiles, whether producers or traders, for example. Connected to the genre and geographic spread of our sources, another dimension can also be added: whether the evidence derives from secular or monastic communities.[8] The same

4. For example, Dubois 2009 and 2013 and Mirecki 2012; the opening line of Dubois 2009, p. 203 is especially illuminative in this respect: "La fouille manichéenne de l'oasis de Dakhlah, l'antique Kellis, a profondément modifié notre perception de l'histoire des manichéens en Égypte". At the very least, Manichaeism is typically highlighted as a key feature of documents from the village.

5. The respective doctoral research of Brand and Teigen (see note 2) demonstrates the amount of substance that can be extracted from the available material.

6. This topic has received some attention, see Franzmann 2007.

7. Boud'hors and Durand 2002, p. 105.

8. For an overview of the monastic evidence (archaeological, artistic, and textual) for clothing in Egyptian monasteries, see Mossakowska-Gaubert 2015. One could also add the use-context in terms of clothing produced to be worn during life and

issues also concern the Greek textual sources. The Kellis corpus mitigates many of these problems:

- The chronology of the documents is restricted. While none of the Coptic documents provide dates, several Greek documents do, mentioning both emperors and consuls, starting at least with the reign of Diocletian (*P. Kellis* I 1 dates to 293/294).[9] These dates correspond with the numismatic evidence from House 3, which provides dates from the final decade of the third century to 394 at the latest.[10]
- The provenance of the documents is certain. The majority of the texts were written by members of the community, whether they were located at the time of writing in the Oasis or the Valley.
- The same individuals who wrote the letters were also involved in textile production, and so technical terms and garment names are standard between all writers of the letters.
- Connected with the above two points, the documents derive from the same context. Even items made for religious purposes were produced in the same place and by the same people as the other textiles mentioned in the sources.[11]

This clearly delineated temporal and spatial body of evidence therefore provides an opportunity to study the workings of the domestic textile industry in detail in a single time and place. Additionally, the wealth of the written sources, in both Coptic and Greek, is a veritable goldmine for: materials (raw material, dye, thread, fabric), production (dyeing, spinning, setting up looms, weaving), equipment (looms, tools), products (garments and furnishings), and professional matters (costs, wages, trades). The appendix below collects the attestations of these terms, divided into these five categories.[12]

It is beyond the scope of this article to provide discussions of all the terms found in the corpus, and so a few examples are highlighted here to show the contribution that Kellis can make to the 4th century textile lexicon. Before beginning, one particular issue pertaining to Coptic texts should be noted that is as prevalent in these sources as it is with all Coptic texts that mention textiles: the use of the generic term ϩⲁⲉⲓⲧⲉ. Unless accompanied by further specifications – or a very clear context –, the term simply means "garment".[13] It is possible that the term refers to a simple and common garment (*i.e.* a tunic), but it may refer to anything, the nature of which is well known to the parties in the correspondence. At the other extreme, many words occur just once in the Kellis record and are either significant additions to a small body of attestations from Egypt or entirely new contributions to the lexicon.

Δελματίκιον, τό; *'Dalmatian' robe*

In *P. Kellis* I 7,11, the writer Harpokration requests the recipient, Gena son of Pataias, to send him his 'Dalmatian' tunic. No extra information or details about this specific garment are provided.[14] This garment type also occurs in other 4th century documents, including *P. Oxy*. LI 3626, 17 (δαλμ<ατ>ικ(ῶν)) and *P. Oxy*. LIV 3776 (δαλματικ(ῶν)), both of which are declarations of prices by guilds in Oxyrhynchus.[15] In each document, three different grades of large-size women's Dalmatian tunic (δαλματικῶν γυναικείων ταρσικῶν μεγάλου μέτρου) are listed, but prices are only included in the second document. However, it should be noted that these prices do not represent the fixed market retail price of the garments, but either the prices paid

textiles produced specifically for funerary purposes. For example, sheets and bandages discussed in texts from monastic circles in western Thebes appear to have been produced specifically for burials (Cromwell 2017), in contrast to the variety of textiles found with the body of a woman, 'Tgol', in Antinoupolis (Fluck 2014).

9. *P. Kellis* I 62 is perhaps earlier, possibly dating either to the reign of Probus or Aurelian (and so 273/4 or 279/80); for the issues in dating this document, see the commentary to line 1 of the text.

10. For the numismatic evidence, see *P. Kellis* V p. 111–115.

11. An example of an item made specifically for religious purposes (and which is not otherwise mentioned in this article) is a decorated cushion produced for a Manichaean book (*P. Kellis* V 21, 24–25: ⲧⲛ̄ⲛⲁⲩ ⲡⲱϫⲁⲧ ⲛⲏⲓ ⲛ̄ⲭⲏⲫⲉ ⲙ̄ⲡⲭⲱⲙⲉ, "Send me the dyed cushion for the book"). This point is discussed by Mattias Brand in Chapter 4 of his doctoral thesis (see note 2).

12. Another category that could be included is descriptions, principally of colour and quality/condition, *e.g.*: καλόχρωμος, "nicely coloured" (*P. Kellis* I 72, 36); ⲛⲁⲛ≠, "good" (*e.g.*, *P. Kellis* VII 58, 15); ⲱⲙⲁⲧ, "fine" (*e.g.*, *P. Kellis* VII 58, 16,18); ϩⲁⲩ, "bad" (*P. Kellis* VII 76, 24).

13. In the 5th century texts written by the abbot of the White Monastery, Shenoute, the term seems to refer to the main monastic tunic, as discussed in Cromwell (forthcoming).

14. For the 'Dalmatian' robe more generally, see Mossakowska-Gaubert 2017, p. 323–324.

15. See the discussion in the introduction to *P. Oxy*. LI 3624–3626.

by the trader or guild or the value of the items in stock at the end of the reporting period.[16] To the best of my knowledge, the term does not occur in any Coptic document and it is tempting to credit its occurrence in this Greek letter to the status of the writer, Harpokration: the only other attestation of an individual with this name is *P. Kellis* I 23, in which he is identified as a former magistrate of Mothis (Mut) in the Oasis.

Θώραξ, ὁ (ϑωρⲁ̈ⲝ); *jerkin/scarf?*

This garment appears once in the Kellis texts, in *P. Kellis* VII 58, 23, a business letter that primarily concerns the production of a range of garments. While the address is lost, it is attributed to Orion, who wrote a similar letter to Tehat (*P. Kellis* V 18). The sender refers to fabrics belonging to one Saren (who is also mentioned in *P. Kellis* V 18), who wants fabrics to make some θώραξ (ϥⲟⲩⲱϣ ⲛ̅ⲥ̀ϩⲛⲉ ⲁⲥⲙⲛ̅ⲧⲟⲩ ⲛ̅ⲥ̀ⲛ̅ⲑⲱⲣⲁ̈ⲝ). The editors of the text translate the term as "jerkin", *i.e.*, a sleeveless jacket, due to its etymological meaning connected with chest. Rosanne Livingstone's work on the textile remains from Kellis raises the possibility that the term in this context instead refers to a heavy scarf.[17] As this attestation is the only occurrence of this word in papyri from Egypt in reference to textiles, it is difficult to corroborate such an identification, although any item that covers the chest in some capacity would make sense.

Καμίσιον, τό (ⲕⲁⲙ̣ⲟⲥ̣ⲟⲛ̅); *shirt*

Fifteen ⲕⲁⲙ̣ⲟⲥ̣ⲟⲛ̅ are mentioned in the business account *P. Kellis* V 44, 17, in which they are used as partial payment of freight charges. Despite the poor orthography, the editors are surely correct in identifying the term as καμίσιον, "shirt", which is well attested in Coptic texts of the 7th and 8th centuries.[18] The Greek evidence also post-dates the 4th century, where dates are ascertainable.[19] *P. Kellis* V 44 therefore provides one of the earliest attestations for this garment type in Egypt, and certainly the earliest occurrence in a Coptic document.

Στιχάριον, τό (ⲥⲧⲓⲭⲁ; ⲥⲧⲓⲭⲁⲣⲓⲟⲛ; ⲥ†ⲭⲁⲣⲓⲟⲛ); *(variegated) tunic*

This type of tunic is one of the most common garments found in the Coptic documents from Kellis, but does not occur in the Greek texts.[20] The editors of the Coptic texts do not translate the term, but leave it in transcription.[21] I use here "tunic" (rather than "variegated tunic" as in the *LSJ*), although it could instead be referred to as a long-sleeved tunic.[22] The term otherwise is found, in Coptic, only in a late 6th century list of inherited goods from Elephantine, *O. CrumST* 116, 19, from the archive of Flavius Patermouthis son of Menas.[23] Damage to that papyrus at the beginning of the relevant entry (… ⲥⲧⲓⲭⲁ[ⲣ]ⲓⲟⲛ) means that any further information about the garment is lost. The Kellis material therefore provides an important addition to the existing corpus.

In two Kellis documents, damage has resulted in the loss of any details concerning the garment – whether quality, size, use, etc.: *P. Kellis* V 28, 37 and *P. Kellis* VII 96, 18-19. In two other documents, the tunic is mentioned in passing: *P. Kellis* V 18, 5 and 34, 16. The remaining texts provide information regarding the material and cost of the tunics. Where the material itself is mentioned, it is always wool:[24]

16. On this point, see Bowman 2008, p. 32–33.
17. See the editors' commentary to line 23.
18. See the attestations collected in Förster 2002, p. 373; see also Boud'hors 1997, p. 24–25.
19. According to a search in the papyrological database papyri.info. See further the dates of the evidence collected in Mossakowska-Gaubert 2017, p. 325–327: while the term may appear in the 2nd–3rd century document *SB* XXIV 15922 (from Hermopolis), the term is here heavily reconstructed. All the other textual sources that Mossakowska-Gaubert provides are from the 5th–8th centuries.
20. Hence, the Kellis material is not mentioned in the discussion of this garment type in Mossakowska-Gaubert 2017, p. 332–324.
21. This practice is common, given the difficulties in identifying different garment types; a fact explicitly stated, *e.g.*, by Layton 2014, p. 97 (n. 4) in his translation of the rules of Shenoute, the 5th-century abbot of the White Monastery: "Because the exact distinctions among Coptic garment names are uncertain, these words have mostly been left untranslated".
22. As Mossakowska-Gaubert 2017, p. 332–334 demonstrates, the *sticharion* was a tunic with long, tight sleeves.
23. This document is not included with the Coptic texts in Porten 1996; for its attribution to this archive, see Clackson 1995, p. 98 (which also provides an introduction to the archive, for further bibliography, see the entry in the Trimegistos Archives database: TM Arch id:37 [http://www.trismegistos.org.arch/index]). Förster 2002, p. 751 incorrectly lists the document as unprovenanced.
24. Mossakowska-Gaubert 2017, p. 334 notes that the garment can be produced from linen or wool or a mixture of both. It is not possible to conclude that all garments that do not mention wool are made from linen.

– *P. Kellis* V 26, 15: a query regarding wool dyed the appropriate colour for the writer's black tunic: "If you know that Louitoni has wool good for the colour of my black tunic, take some for me" (ϵϣωπϵ ϵκϲⲁγⲛϵ ϫϵ ογⲛ ϲⲁⲣⲧ ⲛ̄ⲧⲟⲧϥ ⲛ̄ⲗⲟγϊⲧⲱⲛⲓ ϵⲛⲁⲛⲟγϥ ⲙ̄ⲡⲛϵⲟγϵⲛ ⲛ̄ⲧⲁϲⲧⲓϫⲁ ⲛ̄ⲕⲁⲙⲏ ϥⲓ ογϵⲓϵ ⲛⲏⲓ).

– *P. Kellis* V 44, 24: a business account, in which a tunic is mentioned within a longer entry concerning quantities of wool: "5 minus (a) share for the wool of the tunic" (ϯⲟγ ϣⲁⲧⲛ̄ ϯϵ ⲋⲁ ϯϲⲁⲣⲧ ⲛⲛ̄ⲥⲧⲓϫⲁ). From the Kellis evidence, 1 *mna* equates to 323 gm (*P. Kellis* IV, p. 51 n. 68), and so 5 *mna* was 1.615 kg.

– *P. Kellis* VII 75, 14-15 and 41: a letter from Pegosh (in the Valley) to his wife Parthene (in Kellis), with an addendum from Kapitou to his wife Tagoshe. Both men mention wool and request their wives to make a tunic from it, as Kapitou writes: "The small quantity of wool that I sent you: Cut it for a tunic" (ⲡⲓϣϩⲙ ⲛ̄ϲⲁⲣⲧ ϯⲋⲓⲧⲛⲛⲁⲩϥ ⲛϵ ογⲁϫϵϥ ⲛ̄ⲥⲧⲓϫⲁ).

– *P. Kellis* VII 78, 45: a letter from Pegosh (here Pekysis) to his father Hor (here Horos). Despite an area of damage, the tunic is mentioned after a discussion of wool: "(Let) Tagoshe settle (with) Lammon for his 10 *mna* ...[25] and you cut them for me (into) a good tunic" (ⲧⲁϭⲟϣϫϵ ⲛϵⲡⲗ̄ϭ̄ ⲗⲁⲙⲙⲱⲛ ⲁⲃⲁⲗ ⲙ̄ⲡϥⲙⲏⲧ ⲛ̄ⲙⲙⲛⲁ ⲡⲙⲁⲗⲓⲙⲙϵ ⲧϵⲧⲛ̄ⲟγⲁϫⲟγ ⲛⲏⲓ <ⲛ̄>ⲥⲧⲓϫⲁ ϵϥⲣ̄ϣϫϵγ).

The instructions to cut the wool for the tunic suggests that the entire item is made from this material. However, note that Kaptiou refers to only a "small quantity" of wool. Without any further qualification, it is unclear if this means just enough material to produce a single garment or if the wool is intended only for decorative elements.[26] I understand it as meaning the former. Perhaps, in contrast to the *LSJ* translation of "variegated tunic", in Kellis the term *sticharion* is best understood as a woollen – rather than linen – tunic.[27]

Only one document refers to the price of such a tunic. *P. Kellis* V 26, 15 is a letter from Matthias in Hermopolis (el-Ashmunein) to his mother Maria in the village. He refers to a tunic that Pamour sold for 5,000 *talents*, noting that he did not see it and had no idea of its quality, whether it was good or bad (ⲧⲥⲧⲓϫⲁⲣⲓⲟⲛ ⲁⲛ [ⲁⲡ]ⲁⲙⲟγⲣ ⲧⲉⲓⲧⲥ̄ ⲁⲃⲁⲗ ⲋⲁ ⲧ[ϵⲓⲟ]γ ⲛ̄ϣϵ ⲛ̄ϭⲓⲛϭⲱⲣ ⲙ̄ⲡⲓ[ⲛⲟ ⲙ]ϵⲛⲧⲟⲓ ⲅϵ ⲁⲣⲁⲥ ϫϵ ⲛⲁⲛ[ογⲥ] ⲏ ϫϵ ⲥⲋⲁγ). There are two problems concerning the evaluation of this price and comparing its relative value in the Oasis and the Valley. Other documents from Kellis suggest that there was a difference in prices between the two regions: in *P. Kellis* VII 81, Philammon – writing from the Valley – refers to an unspecified quantity of dye that cost 30,000 "at Egyptian price" (ⲁⲓϯ ϣⲁⲙⲛⲧⲃⲁ ⲛϵϥ ⲛ̄ⲧⲓⲙⲏ ⲛ̄ⲕⲏⲙϵ ⲛ̄ϫⲏϭϵ). No document, however, provides any indication of the conversion rate for prices (and there is no indication that Pamour sold at the local Egyptian price or if the 5,000 *talents* refers to the equivalent price in Kellis). As such, comparison with tunics in documents from the Valley is pointless. The second problem concerns the nature of the evidence for prices. In the above discussion of the Dalmatian robe, *P. Oxy*. LIV 3776 was mentioned, which provides prices for different grades of garments, but these are not retail prices. Therefore, the price given in this document for a pair of "third grade tunics" – 133 *talents* 500 *denarii* – does not reflect how much it would actually cost to buy such a tunic (lines 24-27: σ[τ]ιχαρίων ὁ[μ]οίως· … γ εἰδέας ζ(εύγους) α τάλ(αντα) ρλγ (δηνάρια) φ.[28] Furthermore, as Matthias was not sure of the quality of the tunic sold for 5,000 *talents*, it is also not a question of comparing like-for-like.

While it is only possible here to discuss a very limited number of garments, the above selection highlights the scope for future, detailed analysis of the Kellis corpus. While all four terms discussed here are of Greek origin, three occur only in Coptic texts and are either new additions to the body of loan words or demonstrate different applications of the terms in comparison to the previously known body of Coptic documents. Moving forward, it will be interesting to investigate the use of indigenous terms and whether their use in 4th century Kellis is the same or different from sites in the rest of Egypt in later centuries.

Case Study: Wool

Wool is mentioned in over a dozen texts, as ἔριον and ἐριδίον in the Greek texts and ϲⲁⲣⲧ in the Coptic texts. In addition, fleece is mentioned in a small number of documents. Analysis of the material remains of wool from the

25. The word here (ⲡⲙⲁⲗⲓⲙⲙϵ) is unknown to the editors, who suggest it is some kind of aside concerning Tagoshe's debt.

26. A mixed-material tunic is possible; see note 24.

27. The editors of the Coptic texts state that "It seems to be a shirt or linen tunic", but in none of the Kellis documents is it described as such and, as demonstrated, it is only mentioned in connection with wool.

28. Note that in the discussion in *P. Kellis* V, p. 62, the editors mistakenly cite *P. Oxy*. LIX not LIV.

site shows that it derives from sheep, not goats.[29] This material, rather than linen or cotton,[30] has been selected as a case study not only to discuss the nature of the evidence regarding it, but because its use in the Oasis reflects other aspects of life there, including animal husbandry and trade with the Valley.

As a starting point for the discussion of wool is Gillian Bowen's statement concerning sheep-rearing in Kellis: "The herding of sheep along with goats is likely … and a letter addressed to Pamouris, an occupant of House 3, from a certain Pekysis, living elsewhere, does imply that sheep were reared in Kellis for their wool."[31] This letter is *P. Kellis* I 72, in which Pekysis berates Pamouris for not sending him "even one fleece"; Pekysis also asks Pamouris in the letter to purchase wool (note that the men appear in the Coptic texts as Pegosh and Pamour respectively, as already seen above). Bowen's statement raises an important point that needs to be borne in mind when reading letters from Kellis: the location of the writer. In fact, both men – brothers – were residents of House 3, but based on the entire corpus of letters it is more likely that both men were in the Valley when they wrote to each other, with Pegosh in Aphrodito (Kom Ishqaw).[32] There is therefore no evidence that the fleece was procured from sheep in Kellis or anywhere else in the Oasis.

This textual evidence allies well with the zooarchaeological record from the site, which has supplied only one record of sheep (*Ovis aries*). Even this example may be intrusive and not contemporary to the late antique community.[33] This absence of sheep is true of the Dakhleh Oasis since the Neolithic.[34] Without secure textual and archaeological evidence for sheep husbandry in the village, it can be concluded that all wool was imported to Kellis.[35] The necessity to trade and transport the commodity accounts for the relatively high frequency with which it is mentioned in the surviving textual record. In the following letters, the writer seems to be located in the Valley and sends wool to Kellis, or promises to do so at a later point:

– *P. Kellis* VII 71, 34: Pamour writes to Partheni in Kellis and states that when he has need to send goods back to the Oasis, he will include wool: "When I have cause to send out, I will make them <bring> you the portion of wool" (ⲡⲙⲉⲩ ⲛ̄ⲧⲣⲓϫⲁⲩ ⲁⲃⲁⲗ ϯⲛⲁⲧⲣⲟⲩ<ⲛ̄> ⲧⲗⲉⲡⲥⲉ ⲛⲉ ⲛ̄ⲥⲁⲣⲧ).

– *P. Kellis* VII 75, 9, 41: Pegosh writes to Parthene in Kellis, largely with directions concerning textiles, with an addendum from Kapitou to his wife Tagoshe. Pegosh tells Parthene to: "Take these six *mna* of wool and sixteen coils. Take them from Pane, cut it (*i.e.* the wool) for a good tunic; and send it to me. I have paid him for its freight" (ϫⲓ ⲡⲓⲥⲁⲩ ⲛ̄ⲙ̄ⲙⲛⲁ ⲛ̄ⲥⲁⲣⲧ ⲙⲛ̄ ⲙⲏⲧⲉ ⲥⲉ ⲛ̄ⲡⲗⲉⲧⲓ ϫⲓⲧⲟⲩ ⲧⲟⲧⲕ ⲙ̄ⲡⲁⲛⲉ ⲟⲩⲁϫⲕ ⲛ̄ⲥⲧⲓϫⲁ ⲉⲛⲁⲛⲟⲩⲕ ⲧⲉⲧⲛ̄ⲛⲁⲩⲕ ⲛⲏⲓ ⲁⲓⲙⲁϩⲕ ⲛ̄ⲧⲉⲕϩⲙⲉ).

29. Coombs *et al.* 2002, p. 117 and 119.

30. Cotton, ἐρεόξυλον, is mentioned in one Greek letter (*P. Kellis* I 61.6) and several times in *P. Kellis* IV 96, the Agricultural Account Book (sometimes referred to in the scholarly literature as the KAB); of note is that neither wool, linen, nor dye occur in the account book, which typically instead focuses on finished products – cotton is one of the few exceptions. For a brief overview of cotton in Roman Egypt, see Wild *et al.* 2007; for cotton within the oasis context see also the article by Fleur Letellier-Willemin, in this volume (Letellier-Willemin 2020). The importance of cotton within the oasis economy is also discussed in Mattias Brand's thesis (note 2).

31. Bowen 2002, p. 89.

32. *P. Kellis* VII 64–72 are written by Pamour, *P. Kellis* VII 73–79 by Pegosh to various individuals (including each other); their locations are discussed by the editors in the introductions to the respective texts. See, *e.g.*, the introduction to *P. Kellis* VII 66: "A possible context for this piece … is that Pegosh is in Aphrodito, and Pamour and Maria have written to him there from elsewhere in the Nile Valley where they are doubtless engaged in trade. In this case, the letter has been transferred to Kellis at a later date …" (the commentary to the document contains further support for this argument). As the editors state in their introduction to *P. Kellis* VII 75, "The remarkable number of letters found at House 3 can in good part be understood against this background of absence, trade and transport requests."

33. Churcher 2002, p. 106.

34. Churcher *et al.* 2008, p. 17.

35. In general, there is a lack of reference to animal husbandry in Kellis, even though animals were certainly reared there, as the faunal remains demonstrate (see Churcher 2002). In connection with transport – a fundamental aspect of life in the Oasis – camel drivers are mentioned (ϧⲁⲣⲱϩ in Coptic; καμηλίτης in Greek), but camels are only explicitly mentioned in *P. Kellis* V 50 (*e.g.*, line 11: "Take care of the camel!", ϥⲓ [ⲡ]ⲣⲟⲟⲩⲱ ⲛ̄ⲡⲥⲁⲙⲟⲩⲗ). Note that, while *P. Kellis* I 27 mentions the presentation of camel and cattle, the document was sent to Trimithis not Kellis. This is not to say that animal husbandry did not occur in Kellis, but that (1) it is absent from the textual record – it may have been so commonplace that it did not warrant written communication; and (2) the point remains that there is no evidence for sheep rearing.

– *P. Kellis* VII 78, 41-42: Pegosh writes to Hor, telling him to take wool from Andreas, son of Tone, whom Pegosh presumably hired to transport goods back to Kellis while he was in the Valley. See also *P. Kellis* VII 96 below.

– *P. Kellis* VII 79, 33-38: Pegosh writes to Pshai, who has written to him before to acknowledge receipt of wool and to request another two *mna* of wool for warp. Wherever Pegosh is at the time of writing, he is not able to find wool unless he sends further south for it.

– *P. Kellis* VII 96, 33: much of this letter is broken, but Andreas (who may be the same individual named in *P. Kellis* VII 78) delivers wool and the writer states that he has "cleared the freight charge" (ⲁⲓⲙⲁϥ ⲛ̄ⲑⲏ[ⲙⲉ]).

Wool was important in textile production in Kellis, but it was not produced locally and so its acquisition was an element in the economy of the village and formed part of the trade between the Oasis and the Valley.

In the discussion of the *sticharion*-tunic above, it is noted that they seem to be made from wool (or at least that they had substantial woollen components). The other item with which wool regularly occurs is dye. Dyed wool, both unspun and spun (as part of decorative elements of garments) is attested in the archaeological record.[36] Greek texts refer to purple dye, πορφύρα (*P. Kellis* I 61, 72-74), while Coptic uses the term ϫⲏⲃⲉ, which can refer to purple but is the general noun for dye or possibly even dyed goods. As a case in point, in *P. Kellis* VII 103 ϫⲏⲃⲉ is qualified by antimony, ⲥⲧⲏⲙ: "Know that they have brought the necessary other *mna* of antimony–dye, which is excellent quality. I did not send it now, because I have put it aside to be spun here" (ⲙ̄ⲙⲉ ϫⲉ ⲥⲁⲩⲛ̄ ⲧⲕⲉⲙⲛⲁ ⲛ̄ϫⲏⲃⲉ ⲛ̄ⲥⲧⲏⲙ ⲛⲏⲓ ⲛ̄ⲛⲁⲛⲅⲕⲁⲓⲟⲛ ⲉⲛⲁⲛⲟⲩϥ ⲧⲟⲛⲟⲩ ⲉⲣⲉⲙ̄ⲡⲓⲧⲛ̄ⲛⲁⲩⲥ ϯⲛⲟⲩ ϫⲉ ⲛ̄ⲧⲁⲓⲕⲁⲥ ⲁⲥⲉⲥⲧⲥ ⲛ̄ⲛⲓⲙⲁ).[37] Dye, especially purple, as with wool was also transported to Kellis. Both *P. Kellis* I 72 and 74 are in part requests for purple. The second of these texts in particular implies that it was not available locally, as work had to be halted until they received the dye, which was to be used for two female garments (ἀξιωθεὶς κατὰ τὴν συνταγὴν πέμψον μοι τὸ ὀλίγον πορφύρας εἰς χιτώνιον τῆς μητρός μου καὶ τῆς ἀδελφῆς μου, ἐπεὶ χρεία ἐστὶν καὶ κεῖται τὰ σύνεργα ἕως πέμψῃς ταχέως τὴν πορφύραν). A letter, *P. Kellis* VII 81, from Philammon in the Valley to Theognostos also mentions dye: he will send it back to Kellis, so that garments can be produced and returned to him.

This seeming scarcity of purple stands in contrast to its role in *P. Kellis* I 61, an account of "arrears of money in purple" (ἔχθεσ(ις) ἀργυ(ρίου) ἐν πορφ(ύρᾳ)), which seems to indicate that purple was a more stable commodity.[38] *P. Kellis* I 61 is problematic, in that the various commodities that are listed do not have corresponding quantities of purple, and so how much purple was involved is unknown. However, if purple was not common in the Oasis, this could account for its use as a stable commodity used in favour of unstable silver. Its rare nature would also account for the use of cheaper alternatives: it is perhaps not coincidental that the dye analysed to date shows purple to actually be a mix of red and blue dyes.[39] However, the absence of physical evidence of purple may be because garments with purple dye were not left in the village when it was abandoned. Consequently, the lack of purple in the archaeological record may not reflect its actual use in Kellis.

Economics

Wool and dye, especially purple, provide a window into the economics of the textile industry, including the importance of trade with the Valley and the implied cost of transport across the Western Desert, as has already been discussed.[40] Textiles formed one part of trade within wider economic strategies that included a range of commodities, and trade was bidirectional, with materials sent to the Oasis and finished garments sent back to the Valley (in contrast to the unidirectional trade of other commodities, *i.e.*, food items).[41] In addition to the economic contribution

36. See the figures throughout Bowen 2002; as she notes, all the woven wool found on site is in fact dyed.

37. This passage is somewhat problematic, as the *mna* of antimony-dye (literally "dye of antimony") may actually refer to dyed but unspun wool, as the writer (perhaps here Pamour) immediately states that it is currently set aside to be spun. Such references may mean that there are actually more occurrences of wool in the letters, but it is referred to obliquely.

38. See, similarly, *P. Giss*. 103 from Hibis, also in the Western Desert.

39. Coombes *et al*. 2002.

40. Two sites in particular occur in terms of trade with the Valley: Hermopolis (see above in conjunction with *P. Kellis* V 26; see also *P. Kellis* I 66) and Aphrodito (see note 31; see also *P. Kellis* I 32, written to Psais, son of Pamour in Aphrodito). The size of Hermopolis and its markets (for which, see Alston 1998) would make it a particularly attractive location for trade.

41. The Oasis specialised in the production of several commodities, including olives and olive oil. Olives were a stable commodity in Kellis and were produced on a sufficiently large scale to create a surplus; see, *e.g.*, *P. Kellis* V 45, in which 45 litres of oil

made by trade, several documents provide direct evidence for the cost of different aspects of textile production within the village, whether the cost of raw materials, the price of finished goods, or wages paid to various individuals involved in the process. As detailed economic analysis is required of commodities in Kellis and the Oasis across the 4th century, I have selected just two examples to highlight the type of information available.

The cost of cowls

The cowl, Coptic ⲕⲗⲉϥⲧ, appears five times across two of the Kellis documents: a business account, *P. Kellis* V 46, and a letter, *P. Kellis* VII 58. In the former, the cowls, which are not qualified by any descriptors (*e.g.*, concerning quality or shape),[42] are given prices in kind: each costs 10 *maje* of wheat.[43] The second document opens with a discussion over the cost of "good cowls" (ⲛⲕⲗⲉϥⲧ ⲉⲛⲁⲛⲟⲩ).[44] The recipient of the letter and maker of the garment, which may be the woman Tehat, requested 1,300 *talents* for the cowl, but the writer is aggrieved.[45] On one hand, he had assumed it was given as a gift, but also mentions that he could have acquired one – if he has to pay – from the weaver Lauti for 1,200 *talents*. The volume of economic data from the Oasis, especially as a result of the account book *P. Kellis* IV 96, means that the practical value of goods can be compared, *i.e.*, in respect of the actual cost of living. The more expensive cowl could buy the following goods:

- 2.15 *lithos* of cotton (600 *talents* per *lithos*)
- 3.25 *maje* of honey (400 *talents* per *maje*)
- 4–5 chickens (between 240–300 *talents* each)
- 5.5 *artabai* of dates (250 *talents* per *artabai*)
- 5.5 *artabai* of sesame (250 *talents* per *artabai*)
- 5–6 *keramion* of wine (45–54 litres; 200–250 *talents* per *keramion*)
- 8.5 *maje* of jujubes (150 *talents* per *maje*)

As the information given for wheat in the account book is not given in *talents*, it is not so straightforward to give an equivalence. However, in lines 460-461 and 1021-1022, 15 *mation* (*i.e.*, *maje*) of wheat equates to five chickens. Therefore, one chicken equals 5 *maje* of wheat, and thus 5 *maje* of wheat = 240–300 *talents*, and thus 1 *maje* = c. 50–60 *talents*. If this price is mapped onto the cowls in *P. Kellis* V 46, the 10 *maje* items would have a value of between 500 and 600 *talents*, less than half that of the cowl Tehat produced for which she wanted 1,300 *talents*. However, commodity prices fluctuated significantly: the above equivalence of chickens and wheat are from the 5th and 6th indiction years respectively. Line 459, also from the 5th indiction year, has an equivalence of two chickens for 8 *maje*, meaning that one chicken was cheaper, costing 4 *maje* of wheat. If this equivalence was used as the standard, all prices would change. Cross-comparison of commodity prices can be useful, but must be treated with caution.[46]

Wages

Another element essential in the discussion of cost-of-living is how high salaries were in Kellis. *P. Kellis* V 44; 46; 48 and *P. Kellis* VII 58 and 81 mention wages for different textile-related activities (ⲃⲉⲕⲉ and ⲃⲉⲕⲉ-ⲥⲱϩⲉ, which is explicitly connected to weaving).[47] Activities for which payment was received include production of weft and warp, the cutting of pieces, and weaving.

– *P. Kellis* V 44: a business account. Four entries mention wages: (1) for production of 3 *mna* of weft (almost 1 kg) the writer receives a wage of 1,200 *talents* (the equivalent of one of the cowls discussed in the previous section); (2) cutting a cowl receives 200 *talents* and 2 *maje* of wheat (c. 100 *talents*); (3) production of an unspecified quantity of wool for a blanket and provision of warp receives 0.5 *maje* of

are used to repay a debt, and *P. Kellis* V 65, in which the money collected for rents on olive groves compensates for losses incurred elsewhere.

42. These factors cannot therefore be used to explain price differences. Conversely, garment prices cannot be used as an indication of the type of cowl involved. For the archaeological record for cowls and the range of known types, see Linscheid 2011, p. 128–154.

43. On the capacity of the *maje* (ⲙⲁϫⲉ; Greek μάτιον) in Dakhleh Oasis, expressed in terms of the *artaba*, see *P. Kellis* IV, p. 47–48.

44. The editors translate the phrase in the singular, but the plural ending ⲟⲩ indicates several are intended.

45. On Tehat and her role in the textile industry at Kellis, see Franzmann 2007.

46. An additional factor that may have affected the price, which probably cannot be determined from the available evidence, is whether goods were produced for local consumption or trade with the Valley, *i.e.*, the latter would presumably also cover the cost of transportation (mentioned, *e.g.*, in *P. Kellis* V 44; 50; 58; 78; and 79, albeit without mentioning any costs).

47. Comparative analysis with wages from the Valley is possible (see, *e.g.*, wages recorded for the 3rd century Appianus estate in the Fayum, discussed in Rathbone 2007, p. 106–116), but the same issues discussed above concerning the attempted comparisons of prices are also relevant here.

sesame and 0.5 *maje* of black cumin; (4) production of 3 *mna* for weft and 2 *mna* for warp receives 1,200 *talents* each, demonstrating that production of warp was a more expensive task; the salary for weaving this quantity of yarn was 1,616 *nummi*. According to the monetary reforms of 301, this equates to 27 *talents*, but it is doubtful that Diocletian's reforms had much relevance in Egypt, let alone the Oasis.

– *P. Kellis* V 46: a business account. Cutting a garment – the generic term ϩⲁⲓⲧⲉ is used, preventing an identification of the specific type in question – receives a wage of 13 *maje* (the commodity is not mentioned, but presumably it is wheat). This wage is therefore higher than the price of the three cowls mentioned in *P. Kellis* V 44.

– *P. Kellis* V 48: a business account. Unfortunately, the area of the papyrus that mentions wages is damaged, causing loss of the actual amounts involved. What does survive is the final summation, that for thirteen days of weaving, excluding one day of preparation, the two weavers received 800 *talents* (?). The rest of the account includes various other payments and costs, the brief nature of which makes it difficult to follow what money is going to whom and for what purpose.

– *P. Kellis* VII 58: letter, possibly from Orion to Tehat. Weaving wages are mentioned, involving cutting and spinning, but lacunae also result in the loss of prices, if any were written.

– *P. Kellis* VII 81: a letter from Philammon to Theognostos. Philammon launches into a series of grievances, including the cost of dye (mentioned above) and other significant financial problems. If the interpretation of the text is correct, the source of Philammon's complaints wants to charge Philammon 2,500 *talents* as wages for a tunic (ϣⲧⲏⲛ). This high price reflects the high sums of money that occur throughout this letter, and one wonders if a level of exaggeration is added for rhetorical effect.

Returning to the cost of goods, the total value of items would involve the cost of the materials plus wages. However, we only receive snippets of the costs involved, and indications of various aspects that would contribute to the overall price are lacking: the number of garments cut from the quantities of woven material produced (*e.g.*, how many garments could be made from the 3 *mna* of weft and 2 *mna* of warp mentioned in *P. Kellis* V 44?); the additional freight costs on traded goods (and the cost of transport would be distributed over the total number of commodities per shipment); and any added taxes. As a result, even with knowing some prices – raw materials, wages, and retail prices – it is probably not possible to calculate how much profit was made per garment.[48]

Summary

By necessity, the current study has had to be restrictive in its examination of the Kellis material. Nonetheless, the above selected analyses emphasise that the combined written and material sources are a real treasure trove for the study of textiles in a village community. Furthermore, it is a community with a restricted period of occupation, a strong demographic record, and documentation for a wide range of commodities that provides evidence for different aspects of day-to-day life. Consequently, the use of textiles – whether social, economic, or religious – can be situated within a broader context, as one cog in a bigger machine that offers a rare opportunity to examine in detail life in Roman Egypt.

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48. Teigen 2018 attempts to calculate an annual profit based on the information for costs. Apart from highlighting the difficulties involved in doing so, it should be stressed that Teigen's study is based on the assumption that the domestic textile industry at Kellis was on a scale large enough to be making profit. He does not discuss the possibility that textile production was supplemental to other trade, for example, with the individuals producing textiles also involved in the production of other commodities. It should be stressed that many of the garments mentioned in letters are produced for use by one of the parties themselves; see, *e.g.*, *P. Kellis* V 71; 75; 95.

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Appendix: The Vocabulary of the Textile Industry at Kellis

Note that, as a result of the level of orthographic variation of Greek words within Coptic documents, the "standard" Greek spelling is given in the following tables. The Coptic words are written here in the dialect of Kellis.

Table 1: Garments

Term	Translation	Attestation
δελματίκιον	'Dalmatian' robe	*P. Kellis* I 7, 11
δέρμα	Skin	*P. Kellis* I 66, 18
θώραξ	Jerkin / scarf	*P. Kellis* VII 58, 23
ἱμάτιον	Outer garment	*P. Kellis* I 71, 46; *P. Kellis* IV 96, 83,619,753,762, 765,777,784,789,822,1258,1271,1278,1284,1322, 1325
καμίσιον	Shirt	*P. Kellis* V 44, 17
ⲕⲗⲉϥⲧ	Cowl	*P. Kellis* V 18, 7,21; 27, 15; 44, 4; 46, 5,8,9,12; VII 58, 1,21
κολόβιον	Sleeveless tunic	*P. Kellis* V 18, 4,7
λῶδιξ	Coverlet	*P. Kellis* V 47, 21
μαφόρ(τ)ιον	Cape?	*P. Kellis* I 65, 32; V 46, 6
πάλλιον	Over garment	*P. Kellis* V 21, 13
παρακρεμάσιον	Hanging	*P. Kellis* I 71, 49
ⲡⲁⲣⲕ	Pallium	*P. Kellis* V 19, 26
ⲡⲣⲏϣ	Blanket	*P. Kellis* V 19, 25; 33, 10; 44, 25; VII 76, 52; 79, 28; 105, 39
ⲣϣⲱⲛ	Cloak	*P. Kellis* V 18, 14; 19, 24; VII 58, 24,25; 94, 25
ⲥⲁⲓϣ	Set	*P. Kellis* VII 78, 47; 81, 31,40
σάκκον	Sack	*P. Kellis* I 72, 32
στιχάριον	Variegated tunic	*P. Kellis* V 18, 5; 26, 15; 28, 37; 34, 16; 37, 31; 44, 24; VII 75, 14, 41; 78, 45; 96, 18
στρῶμα	Mat, blanket	*P. Kellis* IV 96, 145,1519,1524; V 19, 26; 26, 20; 44, 6,33; 52, 10
ⲧⲁⲙⲓ	Meaning unknown	*P. Kellis* V 19, 36,45
ⲧⲟⲟⲩⲉ	Sandal	*P. Kellis* V 19, 24; 20, 58
φουκάριον	Head cloth	*P. Kellis* V 41, 10; 47, 6; 48, 13,24,44
χιτώνιον	Tunic	*P. Kellis* I 65, 33; 66, [4],24,25; 74, 10
ϣⲁⲧ	Cushion	*P. Kellis* V 19, 25; 20, 35; 21, 24; 22, 12; 24, 3,7; VII 79, 42; 92, 28; 103, 17; 116, 8
ϣⲁϣⲁⲧⲉ	Cushion	*P. Kellis* VII 82, 18
ϣⲛⲧⲉ	Belt, collar	*P. Kellis* V 24, 45,46
ϣⲧⲏⲛ	Tunic	*P. Kellis* VII 81, 43; 105, 18
ϩⲃⲁⲥ	Cloth(es)	*P. Kellis* V 19, 34; 22, 76; VII 75, 30; 81, 22,31,40; 82, 22; 125, 1
ϩⲙⲁⲥ	Clothes	*P. Kellis* VII 78, 48
ϩⲁⲉⲓⲧⲉ	Garment, robe	*P. Kellis* V 12, 9; 19, 23,29,33,36,45; 20, 33; 46, 3; 52, 13; VII 58, 35; 71, 32; 79, 29; 94, 34; 97, 34; 109, 33
ϫⲗⲟⲉ	Cloth bag	*P. Kellis* V 12, 13; 15, 20; 17, 28; 26, 14,59; 40, 8; 44, 18,21; VII 64, 26, 30; 70, 30; 76, 44; 77, 19; 79, 19; 80, 20; 89, 38; 115, 31; 122, 32,35
ϯⲕⲙⲁ	Sample	*P. Kellis* VII 58, 16
ⲟⲁⲟⲉ[ⲧⲱⲛ]	Linen garment(?)	*P. Kellis* V 27, 9

Table 2. Materials

Term	Translation	Attestation
ⲃⲏⲕⲉ	Weft	*P. Kellis* V 18, 13,17; 44, 1,26,28; 47, 4,5; 48, 13,16,36
ἔριον	Wool	*P. Kellis* I 71, 46
ἐριδίον	Wool	*P. Kellis* I 66, 10; 72, 38; 73, 30
ἐρεόξυλον	Cotton	*P. Kellis* I 61, 6; IV 96, 547,556,558,720,1484
κλωστήρ	Thread, yarn	*P. Kellis* VII 111, 36
λάσιον	Rough cloth	*P. Kellis* VII 103, 23
ὀθόνια	Fine linen	*P. Kellis* I 51, 5
πλεκτή	Hank?	*P. Kellis* VII 75, 11
ποκάριον (πόκος)	Fleece	*P. Kellis* I 72, 20
πορφύρα	Purple	*P. Kellis* I 61, 1; 72, 31; 73, 29; 74, 10,23
σαβάνιον	Linen cloth	*P. Kellis* I 72, 34
ⲧⲱⲃⲥ	Dye	*P. Kellis* VII 58, 30
ⲥⲁⲣⲧ	Wool	*P. Kellis* V 44, 23; 48, 41; VII 58, 17,20; 71, 34; 75, 9,41; 76, 21,23,26; 78, 41,42; 79, 31,33,38; 96, 33; 105, 28
ⲥⲁⲣⲧ ⲛⲣⲱϥ	Fleece	*P. Kellis* VII 109, 31
ⲥⲧⲏⲙ	Antimony	*P. Kellis* VII 103, 8
ⲱϯⲧ / ⲱⲧⲓⲧ	Warp	*P. Kellis* V 18, 7; 32, 32; 33, 10; 44, 6,29; 47, 4,7; 48, 35; O.C. 1, 3; VII 58, 25; 79, 32; 109, 33; 111, 26
ϩⲏⲛⲉ	Fabric	*P. Kellis* VII 58, 15,21,23; 70, 31
ϩⲱⲥ	Thread	*P. Kellis* V 21, 21
ⲭⲏⲃⲉ	Purple / Dye	*P. Kellis* V 19, 40; 47, 3,19; VII 66, 15,24 (?); 77, 18; 79, 43; 81, 18,47; 103, 8,24,35,45; 108, 37
ⲃⲁⲣⲃⲣ	Camel wool?	*P. Kellis* V 19, 25; 47, 25

Table 3. Equipment

Term	Translation	Attestation
ἠλακάτη	Distaff	*P. Kellis* VII 58, 27
ἱστός	Loom	*P. Kellis* I 71, 51
κρίκος	Ring	*P. Kellis* I 71, 51 (τὸ σιδηροῦν)
ⲛⲉⲧ	Loom	*P. Kellis* V 19, 31
στατήρ	Loom weight ('stater')	*P. Kellis* I 71, 48

Table 4. Production

Term	Translation	Attestation
ⲙⲟⲩⲭⲧ	to mix	*P. Kellis* V 32, 32; VII 95, 11; 110, 18,29
ⲡⲁϫⲡϫ	to tread, full (?)	*P. Kellis* V 44, 28; 48, 3,4,14
ⲥⲱϩⲉ	to weave	*P. Kellis* V 18, 21; 28, 37; 44, 5
ⲧⲉⲗⲟ	to set up on loom	*P. Kellis* V 33, 14; VII 103, 28
ⲟⲩⲁϫⲉ	to cut	*P. Kellis* V 19, 23; 44, 4; 46, 3,7; 47, 7; 48, 17; 52, 10,12; VII 58, 24,26; 75, 14,41; 76, 29,37; 78, 45; 96, 20; 103, 16,20,29; 111, 38
ⲱⲧϩ	to fix, weave	*P. Kellis* V 17, 49
ϩⲱⲣⲡ	to wet, moisten	*P. Kellis* V 48, 3,5,14
ϩⲓⲥⲉ	to spin	*P. Kellis* V 44, 29; 48, 35,36; O.C. 1, 3,4; VII 58, 18,27; 103, 11,19,28
ϫⲱⲟⲉ	to dye, stain	*P. Kellis* V 47, 2

Table 5. Profession

Term	Translation	Attestation
ⲃⲉⲕⲉ	Wage	*P .Kellis* V 46, 4; 48, 15,18,25,26,33; VII 81, 42
ⲃⲉⲕⲉ-ⲥⲱϩⲉ	weaving wage	*P. Kellis* V 44, 30; 48, 23,40,44; VII 58, 27
γερδιακῆς τέχνης	weaver's trade	*P. Kellis* I 19a (appendix), 11
λινουφικός	pertaining to linen weaving	*P. Kellis* I 12, 19
ⲛⲁⲥⲉ	costs	*P. Kellis* VII 81, 41
ὑφανυ(είῳ?) ἱματ(ίων)	clothes-weaving shop(?)	*P. Kellis* IV 96, 1266

Conclusion

Dominique Cardon

This book, "Egyptian textiles and their production: 'word' and 'object' (Hellenistic, Roman and Byzantine periods)" is both very useful and… frustrating. Indeed, all volumes of transactions of a scientific symposium are bound to be so, since research is a never-ending story. However, this is particularly true of textile research, which involves so many different approaches.

Most of the relevant scientific domains are represented in this volume. There is a good combination of several reports on new research – recently studied archaeological textiles and iconographic documents on weaving – with attempts at syntheses of available evidence, both archaeological and textual, alongside useful critical reappraisals of some long-published hypotheses on the equipment and organisation of production.

Studying Egyptian textile production over the very long period considered in this volume offers endless possibilities. Egypt is, on the one hand, unique in the wealth of different types of complementary historical sources offered by the dry environments of different parts of its present territory. It is also exceptional in the diversity of textile cultures that flourished in the country: the long-mastered techniques linked with flax/linen production being complemented successively by the technological cultures associated with wool, cotton, and lastly silk. On the other hand, Egypt, in many aspects, is representative of the importance and diversity of textiles in the ancient Mediterranean world since Hellenistic times and even more so after its incorporation into the Roman Empire, as argued by Kerstin Droß-Krüpe, following Rostovtzeff.

In this fertile context, the exchanges of diverse experiences, points of view and expertise during the workshop and in the present publication bring forward a wealth of prospects for further research. Among the most prominent must be research into the diversity of weaving looms available to weavers in Egypt at different periods or simultaneously. Were they invented in-country or adopted from elsewhere (Europe, tropical Africa, Middle or Far East)? When? Why do they keep being used? Why are some adopted, others abandoned? Connected with the evolution of the range of available weaving looms is the intriguing evolution of weaves: from linen plain tabbies of different but mostly high qualities, to very complex weaves for fine wool, such as the weft-faced and blocked twill damasks of Roman Egypt which later disappear; from the wool weft-faced compound tabbies of the same period to the later silk compound twills. Questions of fashion? Of technology and technical skills?

Making use of the new resources of archaeometry and of the advances of a diversity of analytical techniques will doubtless help to shed some light on recurring questions, such as the qualities of the fibres and the identification and provenance of the dyes, as demonstrated by some of the contributions in this volume. It is to be hoped that these resources and techniques may be more easily applied in the future to the archaeological textiles currently being discovered in Egypt, and not only to Egyptian textiles preserved in foreign museums.

In the mean time, this volume offers a striking image of the huge contribution of textile production to the economic and social history of Egypt.

Published in Maria Mossakowska-Gaubert, ed., *Egyptian Textiles and Their Production: 'Word' and 'Object' (Hellenistic, Roman and Byzantine Periods)* (Lincoln, NE: Zea Books, 2020). doi 10.32873/unl.dc.zea.1091